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RESIDUAL STRESS AND DIFFRACTION ELASTIC CONSTANTS MEASUREMENTS WITH A PERSONAL COMPUTER

BY

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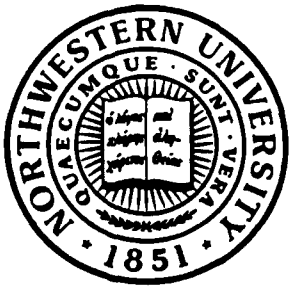

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Residual Stress and Diffraction Elastic Constants Measurements with a Personal Computer

R.A. Winholtz and J.B. Cohen

ABSTRACT

Software is described for the measurement of residual stresses and x-ray elastic constants on a diffractometer under computer control. The computer and interfaces to the hardware are relatively inexpensive and may be set up with only moderate electronic and programming expertise. Both biaxial and triaxial stress measurements may be made to an operator specified error. Measurements of the x-ray elastic constants may also be made to a pre-specified error. Additionally, programs for use data collection are described which allow the data to be processed separately at a later time.

1 INTRODUCTION

With the rise of the personal computer over the last decade, the computer automation of laboratory equipment has become much cheaper and easier. The increased availability, better quality, greater ease of use, and lower cost of computers, interfaces, and software tools now makes the job of computer automation possible for those with only moderate electronic and computer skills.

It is assumed that the reader is familiar with diffraction methods and residual stress measurements. If not the methods and theory are well documented in the literature [1-5].

For stress measurements diffraction peak positions are measured and various sample tilts to determine the stresses. For diffraction elastic constants the diffraction peak positions are measured at a set of sample tilts for different applied loads. The packages use quick multiple scans and a final longer scan to determine the peak positions to a specified precision using parabolic fits to the data. The parabolic fit allows the final peak position precision to be estimated from the quick initial scans. The desired precision in peak positions is computed from the desired errors in the stress values or elastic constants. The operator thus inputs a precision to which the measurements should be made and the programs find the peak positions to the necessary precision. Since determining the stress or elastic

constants to a greater precision requires a greater amount of time the programs will also estimate the time it will take for the measurement after an initial prescan. The operator then has the option to reduce the desired precision if the measurement will take too long or increase the desired precision if more time is available.

Five programs compromise data collection package. Four additional programs will analyze data taken separately. All are designed to run on an IBM PC compatible computer running the DOS operating system. The programs STRESS and ELASTIC are large menu driven programs for making stress measurements and diffraction elastic constants measurements respectively. They both also provide rudimentary diffractometer control and a sample alignment routine. The programs INITPOS, MOVETO, and SCANTTH are smaller command line programs that may be put together in a batch file to be run as a data collection unit whose data are stored in computer files to be processed separately. The programs PEAKFIT, BSTRESS, TRIAXIAL, and MICRO are used to process the collected data. PEAKFIT will determine the diffraction peak position from a data file by fitting the data to a parabola or a nonlinear function such as a Gaussian, a Lorentzian, or a pseudo-Voigt function. BSTRESS will take a collection of peak positions and sample tilts and calculate the biaxial stress. TRIAXIAL takes peak positions and sample tilts and determines the triaxial stress in the sample [3]. MICRO takes the peak positions and sample tilts from two phases in a material and computes the macro- and micro- stress tensors [5].

These programs comprise a complete rewrite of previous program packages [4,6]. The program STRESS incorporates the latest methods in triaxial stress analysis [3]. The programs are written in the pascal programming language and are well commented and easy to read. The programs are highly modularized and hence porting to another installation should be straightforward. The source code is available on floppy disk from the authors for noncommercial use.

2 DESCRIPTION OF THE SYSTEM

The diffractometer and the associated hardware for the measurements are controlled with an IBM PC compatible computer equipped with the necessary interfaces. The data collection program package consists of the following files:

STRESS.EXE
ELASTIC.EXE
INITPOS.EXE
MOVETO.EXE
SCANTTH.EXE
MOTOR.PAR
CURR.POS

The data collection programs in this package are written in Turbo Pascal version 5.5 from Borland International. They also make use of the Technojock Turbo Toolkit for the menus and input screens. Figure 1 shows a schematic of the system as set up in the authors' lab. There are four hardware interfaces needed: (1) Moving motors to control the diffractometer and apply stress to an elastic constants sample, (2) Reading counts from a scintillation or solid state detector, (3) Controlling a multi-channel analyzer (MCA), and (4) Determining the applied stress on a sample with a load cell or a strain gauge.

Interfacing with the hardware is accomplished with the use of cards that plug into the computer bus and are connected via cables to the various hardware components. Two stepping motor driver cards allow the computer to control four stepping motors. A counter timer card allows the computer to read output pulses from a single channel analyzer (SCA) and hence measure the x-ray intensity with a scintillation or a solid state detector system. A LeCroy Model 3001 MCA is controlled with a parallel output card which allows the computer to start, stop, clear, and read a position sensitive detector (PSD) system. To measure applied loads an analog to digital (A/D) and digital input/output multipurpose card is used to read the output of a load cell or a strain gauge. Names and addresses of hardware and software suppliers are listed in Appendix A.

2.1 Stepping Motors

Stepping motors are used to change the diffractometer angle settings and to apply a known load to the sample for measuring the diffraction elastic constants. They are controlled by the computer by using two MSTEP-5 motor control cards in the computer. The MSTEP-5 cards output timed pulses that, in conjunction with Electronic Products stepper motor drivers, control a stepping motor. The motors advance one step for each pulse. The cards are supplied with an assembly language routine that may be called by a high level computer language to do a variety of stepping motor control functions. Each card will control two stepping motors, thus two cards are needed for the four motors in the measurement system.

The software makes the proper motions for diffractometers that have the theta and two theta axes either coupled or uncoupled. The computer moves the diffractometer to desired angular settings by keeping track of the number of steps moved an knowing the amount of angular motion per step. Each time one of the programs is exited the current settings of the diffractometer are written to a file on the computer. When one of the programs is started this file is read so that the motor positions will be correctly stored by the program. These may be changed by the operator if the diffractometer has been moved while not under the program's control.

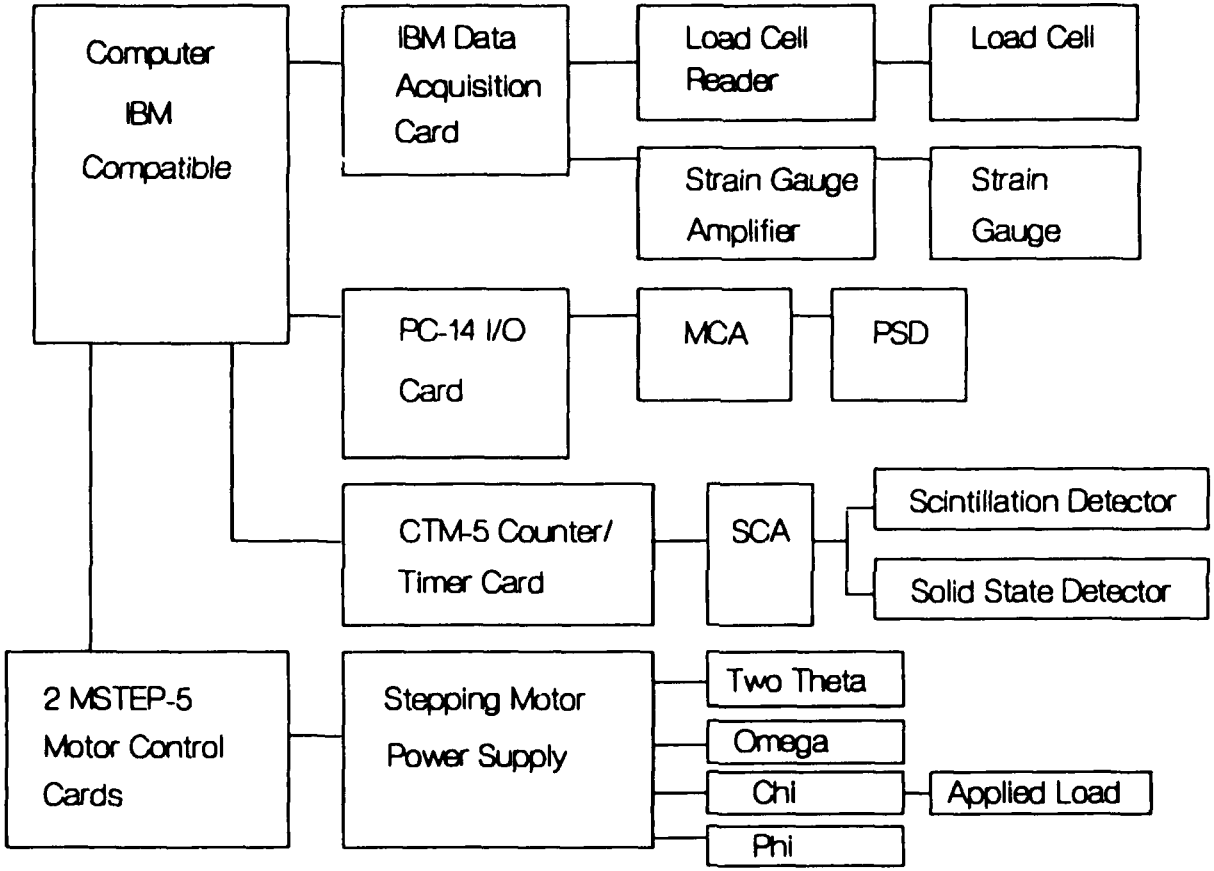


Figure 1

Schematic of Computer and Interfaces for Residual Stress and Diffraction Elastic Constants Measurement System

2.2 Single Channel Analyzer and Detectors

The computer system must be able to measure the x-ray intensity at various angular settings of the diffractometer. This is done with either a PSD or a point counting system. For point counting the output of a scintillation or solid state detector is run through an amplifier and then to an SCA which puts out a pulse for each x-ray absorption event in the detector. The Intensity is then measured by counting the pulses in a given amount of time, or alternately, measuring the time for a given number of pulses to be counted.

The computer system accomplishes this by using a CTM-5 card which connects with the output of an SCA. The card has five counters which will count pulses from a variety of sources under software control. By simultaneously counting pulses from an SCA connected to the card and from an onboard timer and gating the system when a preset number of counts is reached in one or the other the intensity can be measured. The computer may thus measure the intensity at a set of diffractometer settings in either constant counts or constant time mode.

2.3 Multi-Channel Analyzer

Instead of measuring the intensity at a series of two theta values on after another a PSD can measure the intensity over a range of two theta all at once. This can greatly speed up the data collection for a stress measurement. The intensity information for the PSD is stored in a multi-channel analyzer which collects counts representing intensity in different channels each representing a different two theta value.

This system employs a TEC Model 205 PSD. A LeCroy Model 3001 MCA is used to read the PSD signals. To use the PSD the computer must be able to start the MCA counting, stop the counting, clear the channels, and read the data from the different channels. This is accomplished by using a PC-14 I/O card. This card may be programmed to output TTL signals on different lines and also read TTL signal on different lines. By setting certain lines on the MCA may be given different instructions. The MCA is thus instructed to start, stop, and clear itself. The MCA is read by instructing it to present its data for a given channel on output lines which may then be read by the PC-14 card. This interface allows the computer to collect intensity information from a PSD system.

2.4 Load Cell and Strain Gauge

To measure the diffraction elastic constants known loads must be applied to a sample. The computer may apply loads to the sample by moving a motor to either elongate the sample in a tensile devise or by applying a bending moment to the sample in a bending jig [6]. In the tensile device the stress on the sample may be determined from either the load measured by a load cell or from a strain gauge on the sample. In using the bending jig the

stress on the sample is determined from a stain gauge attached to the sample.

The system uses a Sensotec Model 41 load cell. The output of the load cell is read by a Sensotec Model 450-D amplifier and indicator. The Model 450-D outputs the load in pounds in binary coded decimal (BCD) on terminals on its back panel. These terminals are read by the digital inputs on an IBM Data Acquisition and Control Adapter Card one digit at a time. From the load in pounds the program may compute the stress on the sample.

A strain gauge on the sample is included in a bridge circuit and the output on this circuit amplified by a Sensotec SCA-7 Strain Gauge Amplifier. The voltage output of the amplifier is proportional to the strain in the sample which is in turn proportional to the stress. The computer reads this voltage and hence may calculate the strain by use of the analog to digital converter on the IBM Data Aquistion and Control Adapter Card. When read the A/D converter outputs an integer proportional to the voltage output by the strain gauge amplifier. These interfaces allow the computer to measure stresses that have been applied to the sample by moving a stepping motor.

2.5 INPUT FILES

In addition to the program files the system requires two other computer files to operate. To interface properly the programs need to know the particular hardware used and the operating characteristics desired by the user. This is done by reading the files MOTOR.PAR and CURR.POS when the programs are started up. A typical MOTOR.PAR file might contain the following:

```
  0     1     0     1   :Select Channel A=0, B=1
255   255    50    50   :Start Rate
 40    50    20    50   :Run Rate
400   400   400   400   :Accelerate/Decelerate Steps
  2     2     2     2   :Motor Code
  0     0     0     0   :Full/Half Step, 0=Full, 1=Half
  0     0     0     0   :Logic Level, 0=Inverse, 1=True
  1     1     1     1   :Clocksource,0=Internal,1=OnBoard,2=Extern
  1     1     1     1   :Switching at standstill, 0=Off, 1=On
768   768   784   784   :Base Address
  1     1     1     1   :Divider Ratio
800   800 -1600   400   :Motion-to-Steps Conversion
165    65   100   400   :High Limits for Motors
-25   -50   -10  -400   :Low Limits for Motors
2theta                  :Name for Motor 0 (6 Characters)
omega                   :Name for Motor 1 (6 Characters)
chi                     :Name for Motor 2 (6 Characters)
phi                     :Name for Motor 3 (6 Characters)
2.2909                  :Wavelength in angstroms
8.5                     :Goniometer Radius in inches
1.5E-6                  :Detector Deadtime
false                   :Using a PSD?
true                    :Theta and Two-Theta coupled?
```

Each line contains some parameters and then a colon and then a comment. The program reads only the information on each line

ahead of the colon. The comments are there just as an aid in modifying the files. The first 11 lines are operating parameters for the motors. These are used to program the motor drivers. The motors are driven by two MSTEP-5 cards, each card controlling two motors. Each line contains the parameter for motor 0 through motor 3. The complete definitions of these terms are given in the manuals that come with the MSTEP-5 cards. Note that the base addresses of the two cards must be different. These are set on the MSTEP cards with dip switches. Make sure the settings on the cards match the addresses in the file.

The next line is the steps to motion conversion values. These are used by the program to compute the number of motor steps necessary to achieve a desired amount of motion. The units of these values will be in steps per degree. If 800 motor steps gives one degree of motion on the diffractometer the value should be 800. A plus or minus sign will give the necessary direction of motion. For automated sample repositioning in aligning the sample the phi motor is used and the steps to motion value should be in steps per inch or steps per cm.

The next two lines give the high and low motion limits for the motors. These are in degrees. If automatic sample repositioning is used in the alignment part of the program, the phi motor is used and the limits should be in the same units of length as the steps to motion ratio given in line 12. The high limits on the line are for motors 0 through 3 respectively as are the values on the line for the low limits.

The next 4 lines give names for the motors as they will appear on the initialization screen. Six characters are all that is read. These should not be changed in order. Motor 2 may be named "load" if it is being used by the program ELASTIC.

The last five lines give the default values for the current diffractometer set up. The wavelength is the next item in the file. This is the value of the wavelength of radiation currently being used. One may change this value in the program if desired. The value read here is the default. The same is true for the goniometer radius. This is the distance from the x-ray source to the sample surface. This should also be the same distance as from the sample surface to the receiving slits or the PSD wire because receiving slit motion is not used in this program. The detector deadtime is used to make intensity corrections to the data in determining the peak positions. It too may be changed within the program and the value read from the file is the default. The next line should be a "true" or a "false" indicating whether or not a PSD is being used to make the measurements. Actually only the first letter is read. Again, this is only the default value and this may be changed in the program. The last value again should read "true" or "false" indicating whether the diffractometer has theta and two-theta coupled or not. A coupled diffractometer is one where one motor moves both the sample and the detector arm keeping the theta-two-theta geometry correct and a second motor moves the sample an additional motion for omega. An uncoupled diffractometer is one where one motor moves both theta and omega and another motor moves just two-theta. For an uncoupled diffractometer two motors

must be moved to do a two-theta scan while for a coupled diffractometer only one motor must be moved. Picker diffractometers are coupled while Huber diffractometers are uncoupled. This line again gives only the default value.

The file CURR.POS gives the default values for the current motor positions. If the file does not exist the default values are taken to be zero. Each time the program is exited this file is rewritten with the current motor positions, so if one does not exist it will be created when the program is first exited. This allows the operator to use the program and then exit it to use the computer for other things and come back to the Stress program and still have the current motor positions present.

2.6 OUTPUT FILES

Output for the programs is to a file on disk and to the computer screen for the operator to see as the data is being taken. Data is stored as it is taken so that data will not be lost in case of a power failure or other catastophy. For the programs STRESS and ELASTIC the operating parameters as initially chosen are first written to the file. As peak positions are found the raw data, the peak position and error is appended to the output file. Finally, the report is appended to the file giving the final results. Example output files will be presented later. The program SCANTTH outputs three columns, the two theta angle, the counts, and the time counted. Each point is appended to the output file as the data is taken.

3 USING THE PROGRAM STRESS

The program STRESS gets the information needed to make stress measurements from the operator through a series of menus and input forms on the screen. The choices are made and the correct information is input into the fields on the forms and then the "END" key is pressed to accept the values as currently shown on the screen. The "END" key is also the "1" key on the numeric keypad. The user is given default values which may be accepted or changed as desired.

When the program is initially run by typing "STRESS [return]" the first screen that appears is one to input the proper hardeware configuration and current motor positions. This screen is shown below.

```
        2theta      =    154.845
        omega       =      0.000
        chi         =      0.000
        phi         =      0.000

  Goniometer Radius       :  8.500  inch
  Detector Deadtime       :  1.5E-06
  Wavelength              :  2.290900
  Using a PSD             :   false
  Theta/TwoTheta Coupled  :   true
```

```
Input the correct values
Press "End" to continue
```

The current motor positions are requested as well as the goniometer radius, the detector deadtime, the x-ray wavelength used, whether or not a PSD is being used, and whether or not the theta and two-theta axis are coupled. The default values presented are read from the files CURR.POS and MOTOR.PAR. The motor positions are stored when the program is exited so that if nothing has been changed from the last time the program was used they will all be correct. The other parameters are stored in the file MOTOR.PAR. The defaults may be changed by editing this files. The user should be sure that all the information is correct and then hit the "END" key to accept these values.

After inputting the hardware configuration the main menu comes up:

```
Stress Measurement Program:  Version 1.00
R.A. Winholtz, (c) 1989 Northwestern University

F1 Biaxial Stress Measurement
F2 Marion-Cohen Analysis
F3 Triaxial Stress Measurement
F4 Align Sample
F5 Diffractometer Control
F6 Calculations
F7 Quit
```

From this menu the user can select what function should be performed by the program. The choices "Biaxial Stress Measurement" and "Marion-Cohen Analysis" both perform a biaxial stress measurement. The "Marion-Cohen Analysis" choice implements the Marion-Cohen analysis for nonlinear d vs. sin squared psi behavior after the biaxial stress analysis [7]. "Triaxial Stress Measurement" performs a triaxial measurement by least squares [3]. The choice "Align Sample" gives a measure of

the sample displacement using a fit of the lattice parameter to the Nelson-Riley function [1]. Automated sample repositioning can be used if the phi-motor is hooked up to the sample stage. The choice "Diffractometer Control" is used to move the motors around and make scans of the various angles as well as count with the detectors. This is useful for diffractometer and sample alignment purposes. The "Calculations" choice allows only for the calculation of elastic constants from single crystal values. If calculated these elastic constants will become the default values for biaxial or triaxial stress measurements. Other calculations may be easily added to the program such as fitting pre-existing data to get stress values or fitting peaks with nonlinear functional forms. The "Quit" choice exits the STRESS program.

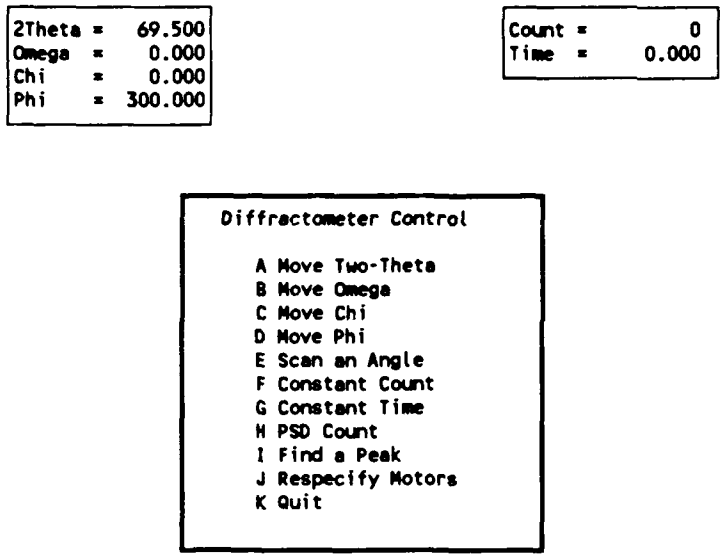
For stress measurements the next sequence of screens depends upon whether a PSD or step counting is being used. The following sections will show the steps necessary to make the different measurements with the STRESS program. The Marion-Cohen analysis and sample alignment may only be done with step counting.

3.1 Calculations

When the Calculations choice is selected the user is prompted for the single crystal compliances S_{11}, S_{12}, and S_{44} as well as the hkl of the peak used. The Voigt, Reuss, and average elastic constants S_1 and $S_2/2$ are then computed. The average elastic constants become the default values for stress measurements.

3.2 Diffractometer Control

The menu for the "Diffractometer Control" option of the main menu is shown below.



The first four choices allow you to move the various angles around. The axes of the diffractometer are the standard ones for a four circle diffractometer as defined in the International Tables for X-ray Crystallography [8]. The zero positions and sense of positive rotation used by the program for stress measurements differ from the definitions in the International Tables however. These differences in definition are made so that the phi and psi tilts for stress measurement will correspond numerically to the axes used to achieve those tilts. The omega axis is zero when the sample surface normal is coincident with the diffraction vector. A positive omega is defined in the same sense as a positive two theta. In this way a positive psi tilt corresponds numerically to the omega value for omega-goniometry. Chi is defined as zero when the sample surface normal is along the diffraction vector. In this way the value of chi corresponds to the value of psi in psi goniometry.

The next choice allows the user to make a step scan of any of the four angles on the diffractometer. The data is stored in a file designated by the user. The file contains the data in three columns, angle, counts, and time.

Constant Counts allows the user to measure the time it takes to accumulate a given number of counts. Constant Time measures the counts accumulated in a given amount of time. These two choices are useful for determining the x-ray intensity.

The choice PSD count allows the user to turn on the PSD for a given amount of time and store the data in a designated file. Find A Peak will use the peak finding algorithm of the program to locate a diffraction peak to a prespecified accuracy.

Respecify Motors brings up the initial input screen. This allows the user to reinitialize the current diffractometer settings and hardware set up.

3.3 Sample Alignment

For the "Align" option the program asks for the number of peaks to use and whether or not the user wants to specify the accuracy to find the peaks to. If the user does not want to specify the accuracy for peaks, the default is 0.01 degrees. The program then asks for the h,k,l for the peaks and the information to find the peaks. An example input screen is shown below.

```
How many peaks? 3
Do you want to specify the accuracy to find the peaks to? (Y/N)

Input the necessary information

H   K   L    Initial TwoTheta   Delta1   Delta2    Accuracy

1   1   0        67.8            0.1      0.05       0.01
2   0   0        105.8           0.1      0.05       0.01
2   1   1        155.8           0.2      0.1        0.01
```

3.4 Biaxial Stress Measurement

3.4.1 Biaxial Step Counting

For a biaxial stress measurement with step counting the following sequence of input screens will come up:

1) An output filename is requested as shown. All the remaining parameters and options input are stored in the output file as well as the experimental results.

```
Give an output file name:
```

2) An experimental parameters form, as shown, is next presented.

```
Omega or Psi Goniometry      : O
Subtract Background          : Y
Specify Desired Error        : Y
Scattering Factor Correction : N
Oscillate Sample             : N
Peak Shift Correction        : N
Number of Psi Tilts          : 6
S2/2                         : 5.77E-06
```

First, the user chooses omega or psi goniometry. Omega goniometry uses the omega axis of the diffractometer to achieve the sample tilts, while psi goniometry uses the chi axis of the diffractometer to achieve the tilts. Subtract Background instructs the program to measure the background at an angle given later in refining the top 85 percent of the peak. It has shown that this improves the precision of peak location [4,9]. The next question is whether to specify the desired error in stress or not. If the operator wants to specify the error he/she will be asked for the error to make the measurement to. If the error is not specified the operator is asked to specify an error in two theta to find each peak to. The operator may make a correction to the data for the change in scattering factor across broad peaks. If selected, the operator is asked for the value of the scattering factor at two different two theta values and the correction is made to the data by linear interpolation between the values. If Oscillate Sample is chosen the sample is oscillated in the final counting. This will help give better sampling to samples with large grain size or texture. The peak shift correction applies a correction to the peak positions to account for the shift in the peak position due to doublet overlap. Next, the number of tilts used to measure the stress should be input. Finally, the elastic constant to be used should be input. For all these inputs a default value is put on the input form which will be accepted if the operator does not change it.

3) The psi tilts to use are requested as shown. The user should input the desired psi tilts or take the defaults and press "END".

Psi[1] =	0.00
Psi[2] =	18.43
Psi[3] =	26.57
Psi[4] =	33.21
Psi[5] =	39.23
Psi[6] =	45.00

4) The information needed to find the peaks by step scanning is requested as shown.

Number of fitting points	:	7
Initial Two-Theta	:	155.0
First step increment	:	0.20
Second step increment	:	0.10
First Counts (1000)	:	1000
Second Counts (5000)	:	5000
Background angle	:	145.0

These parameters are used in the peak location algorithm given in Reference 4. The first line requests the number of points used to determine the peak by parabola fitting. The

next line requests the two theta position to begin the peak search at. This should be at a two theta value below the peak for any tilt of the sample. The first step increment is the step size for the first scan of the peak. The program begins at the initial two theta and scans up the peak in increments of the first step. At each point the value of First Counts is collected and the intensity calculated. The first scan continues until the intensity is less than 90% of the maximum intensity found. The program then returns to the position of maximum intensity found and steps down both sides of the peak by the increment given in Second Step. Again at each point the value of First Counts is counted and the intensity calculated. These scans proceed until the positions of 85% of the maximum intensity found are located. The program then does a three point parabolic fit to the intensities measured at the 85% positions and their midpoint using the Second Counts value. This three point parabolic fit is used to refine the region to fit the final parabola to. The 85% positions are calculated based on the three point fit and the region divided up into the proper number of points for the final scan. Before the final scan a scan is made at the final positions, collecting First Counts. Based on this scan at the final positions, the number of counts for the final scan is computed which will give the needed error in peak position.

5) The information needed for error determination is then requested as shown.

Include Instrumental Error	:	Y	
Estimate Time	:	Y	
Desired Accuracy	:	50	MPa
Approximate Peak Position	:	156.000	

If the operator specified that the time for the measurement be checked a prescan is done and the time estimated. The operator is then allowed to change the initial precision requested if the time is unacceptable. If the instrumental error is to be included a form for inputting the information needed for its computation is presented. The form presented depends upon whether omega or psi goniometry was selected. For omega goniometry the following form is presented which asks for the diffractometer's horizontal divergence, the sample's displacement, and the psi axis missetting.

Horizontal Beam Divergence	:	1	Degrees
Sample Displacement	:	0.0010	Inches
Psi Axis Missetting	:	0	Inches

While for psi goniometry the program additionally requests the vertical displacement of the x-ray beam.

Horizontal Beam Divergence	:	1	Degrees
Psi Axis Missetting	:	0	Inches
Horizontal Sample Displacement	:	0.0010	Inches
Vertical Beam Displacement	:	0.0010	Inches

6) A message to open the shutter and hit any key to proceed is given and the measurement started when the operator next hits a key.

Open Shutter, Hit Any Key To Proceed.

The program will then proceed to make the biaxial stress measurement. As the program does the measurement the current angles, counts, and time will be displayed. This allows the user to follow what the program is doing. A box opens which fills in with the psi tilts, peak locations, and errors in peak locations as the program determines these data. This is shown below.

2Theta	=	155.200
Omega	=	0.000
Chi	=	0.000
Phi	=	0.000

Count	=	1000
Time	=	0.000

Psi	TTH	STD
0.000	155.9871	0.01204
18.430	156.0216	0.01037
26.570		

When complete the program will report the stress and error with other relevant information on the screen as shown.

```
Stress =    -204.79 +/-   28.6989
Counting Error     =   28.68267
Instrumental Error =    0.94967

slope = -1.3832E-03 intercept = 1.17063E+00 q = 0.94967

        Psi      Peak      STD(Peak)

      0.000    156.2175    0.04398
     18.430    156.2484    0.01020
     26.570    156.3491    0.04163
     33.210    156.4533    0.07772
     39.230    156.4426    0.03134
     45.000    156.5082    0.02970
```

The information from all the input forms as well as the results will also be in the output file. Pressing any key at this point will return the user to the main menu.

3.4.2 Biaxial PSD Measurement

For a biaxial stress measurement with a PSD the sequence of screens is:

1) The output filename is requested.

```
Give an output file name:
```

2) The experimental parameters are requested as shown.

```
Omega or Psi Goniometry      : O
Subtract Background          : Y
Specify Desired Error        : Y
Scattering Factor Correction : N
Oscillate Sample             : N
Peak Shift Correction        : N
Number of Psi Tilts          : 6
S2/2                         : 5.77E-06
```

These options all have the same meanings as in the step counting case, except the "Subtract Background" option. If background is to be subtracted the operator is then requested to give the channel number for the background intensity as shown.

```
Input channel number of the background:  100
```

3) The psi tilts are requested.

```
Psi[1] =  0.00
Psi[2] =  18.43
Psi[3] =  26.57
Psi[4] =  33.21
Psi[5] =  39.23
Psi[6] =  45.00
```

4) Next, the data for the PSD calibration data are requested as shown.

```
Degrees/Channel  =  0.020000
Two Theta zero   =  155.000
Channel number   =  500
First Channel    =  0000
Last Channel     =  1023
```

```
Input the degrees per channel on the PSD
```

```
Hit "End" to input current values
```

The "Degrees/Channel" refers to the degrees two theta that correspond to each channel of the MCA. "Two Theta zero" refers to the two theta value that corresponds to "Channel number" in the MCA. "First Channel" and "Last Channel" are the first and last MCA channels to be read by the program. The diffraction peak should be contained within this channel range for all psi tilts.

5) Information for the error estimation is requested as shown. This is like the screen for biaxial step counting except it has one additional input for PSD cycling time. This is the time that the PSD goes on between checking the peak fit. The PSD cycles until the peak fit is found accurately enough to give the desired error in stress.

```
Include Instrumental Error :      Y
Estimate Time              :      Y
Desired Accuracy           :     50    MPa
Approximate Peak Position  :  156.000
PSD Cycling Time           :      5    sec
```

6) If instrumental error is to be included the necessary information is requested as in Figure 3-10.

```
Horizontal Beam Divergence :        1  Degrees
Sample Displacement        :   0.0010  Inches
Psi Axis Missetting        :        0  Inches
```

7) A message to open the shutter and hit any key to proceed.

```
Open Shutter, Hit Any Key To Proceed.
```

The program then proceeds to make a stress measurement using the PSD and reports the results just as in the step counting case.

3.5 Marion-Cohen Analysis

If Marion-Cohen analysis is chosen the program will ask the operator for the degrees two-theta below the peak at which to measure the background. This is shown below.

```
For Marion-Cohen analysis input degrees
below peak to measure the background:  2
```

All other input is exactly the same as for a biaxial stress measurement with step counting. After making a biaxial stress measurement the program checks the q value from the results. If it is less than 0.9 then the data is deemed nonlinear and the Marion-Cohen analysis is implemented. If it is not implemented the user is notified that the Marion-Cohen analysis is not used. The background is measured below each peak and the peak intensities measured for the distribution function. Details of the Marion-Cohen method and its implementation in an automated package are given in References 7 and 9.

3.6 Triaxial Stress Measurement

3.6.1 Triaxial Step Counting

For triaxial stress measurements a similar set of screens is used to get the necessary information for the experiment. For a triaxial measurement by step counting they are:

1) A file name is requested.

```
Give an output file name:
```

2) The experimental parameters are requested. This screen is shown in below. In addition to the parameters needed for the biaxial measurement the elastic constant S1 is also input.

```
Omega or Psi Goniometry      : O
Subtract Background          : Y
Specify Desired Error        : Y
Scattering Factor Correction : N
Oscillate Sample             : N
Peak Shift Correction        : N
Number of Tilts              : 31
S2/2                         : 5.77E-06
S1                           :-1.25E-06
```

3) The phi and psi tilts to be used are requested.

```
Psi[1] =   0.00  Phi[1] =   0.00   Psi[17] = 18.43  Phi[17] =180.00
Psi[2] =  18.43  Phi[2] =   0.00   Psi[18] = 26.57  Phi[18] =180.00
Psi[3] =  26.57  Phi[3] =   0.00   Psi[19] = 33.21  Phi[19] =180.00
Psi[4] =  33.21  Phi[4] =   0.00   Psi[20] = 39.23  Phi[20] =180.00
Psi[5] =  39.23  Phi[5] =   0.00   Psi[21] = 45.00  Phi[21] =180.00
Psi[6] =  45.00  Phi[6] =   0.00   Psi[22] = 18.43  Phi[22] =240.00
Psi[7] =  18.43  Phi[7] =  60.00   Psi[23] = 26.57  Phi[23] =240.00
Psi[8] =  26.57  Phi[8] =  60.00   Psi[24] = 33.21  Phi[24] =240.00
Psi[9] =  33.21  Phi[9] =  60.00   Psi[25] = 39.23  Phi[25] =240.00
Psi[10] = 39.23  Phi[10] = 60.00   Psi[26] = 45.00  Phi[26] =240.00
Psi[11] = 45.00  Phi[11] = 60.00   Psi[27] = 18.43  Phi[27] =300.00
Psi[12] = 18.43  Phi[12] =120.00   Psi[28] = 26.57  Phi[28] =300.00
Psi[13] = 26.57  Phi[13] =120.00   Psi[29] = 33.21  Phi[29] =300.00
Psi[14] = 33.21  Phi[14] =120.00   Psi[30] = 39.23  Phi[30] =300.00
Psi[15] = 39.23  Phi[15] =120.00   Psi[31] = 45.00  Phi[31] =300.00
Psi[16] = 45.00  Phi[16] =120.00
```

4) The information needed to find the peaks by step scanning is requested as for the biaxial case as shown.

```
Number of fitting points :      7
Initial Two-Theta        :  155.0
First step increment     :   0.20
Second step increment    :   0.10
First Counts (1000)      :   1000
Second Counts (5000)     :   5000
Background angle         :  145.0
```

5) The unstressed d-spacing is requested.

```
Input the unstressed d-spacing:  1.17119
```

If the unstressed d-spacing is unknown an approximate value will suffice. The error in d-spacing will cause an error in the hydrostatic component of the stress. The deviatoric part

of the output will not have an error due to using an approximate unstressed d-spacing [5].

6) The information for estimating the errors is next requested.

```
Include Instrumental Error :      Y
Estimate Time              :      Y
Approximate Peak Position  :  156.000
```

7) If instrumental error is to be included this information is next requested.

```
Horizontal Beam Divergence :        1  Degrees
Sample Displacement        :   0.0010  Inches
Psi Axis Missetting        :        0  Inches
```

8) The program next asks for the accuracy to which the peaks should be found.

```
Input the accuracy to find the peaks to:  0.01
```

The errors in the stress tensor are then calculated and reported to the user as shown below. The user can then accept these values or not. If they are not accepted the user inputs a new accuracy to find the peaks to and the new errors in the stress tensor are calculated. This process is continued until the operator is satisfied with the errors.

```
            Counting Error  Instrumental Error
Stress 11      9.29093          5.53006
Stress 22      9.29093          5.53006
Stress 33      5.48515          4.45560
Stress 12      3.53859          0.00000
Stress 13      1.34624          0.00000
Stress 23      1.34624          0.00000


  Is this OK (Y/N)?
```

9) A message to hit any key to proceed is then displayed.

```
Open Shutter, Hit Any Key To Proceed.
```

After hitting a key the program then proceeds to determine the peak positions and calculate the measured stress tensor. When

the measurement is complete the stress tensor and the error tensor are displayed as shown. These tensors are also written to the output file.

```
                -425.24     20.59    -81.60
Stress =          20.59   -502.92      6.18
                 -81.60      6.18   -289.73


                  27.99     11.12      4.44
STD(Stress) =     11.12     29.37      4.14
                   4.44      4.14     18.07

Press any key to continue
```

3.6.2 Triaxial PSD Measurements

For triaxial stress measurements with a PSD the following is requested by the program:

1) The output filename as in Figure 3-5.

```
Give an output file name:
```

2) The experimental parameters are requested.

```
Omega or Psi Goniometry      : O
Subtract Background          : Y
Specify Desired Error        : Y
Scattering Factor Correction : N
Oscillate Sample             : N
Peak Shift Correction        : N
Number of Tilts              : 31
S2/2                         : 5.77E-06
S1                           :-1.25E-06
```

3) Next, the phi and psi tilts to be used are requested.

Psi[1] =	0.00	Phi[1] =	0.00	Psi[17] =	18.43	Phi[17] =	180.00
Psi[2] =	18.43	Phi[2] =	0.00	Psi[18] =	26.57	Phi[18] =	180.00
Psi[3] =	26.57	Phi[3] =	0.00	Psi[19] =	33.21	Phi[19] =	180.00
Psi[4] =	33.21	Phi[4] =	0.00	Psi[20] =	39.23	Phi[20] =	180.00
Psi[5] =	39.23	Phi[5] =	0.00	Psi[21] =	45.00	Phi[21] =	180.00
Psi[6] =	45.00	Phi[6] =	0.00	Psi[22] =	18.43	Phi[22] =	240.00
Psi[7] =	18.43	Phi[7] =	60.00	Psi[23] =	26.57	Phi[23] =	240.00
Psi[8] =	26.57	Phi[8] =	60.00	Psi[24] =	33.21	Phi[24] =	240.00
Psi[9] =	33.21	Phi[9] =	60.00	Psi[25] =	39.23	Phi[25] =	240.00
Psi[10] =	39.23	Phi[10] =	60.00	Psi[26] =	45.00	Phi[26] =	240.00
Psi[11] =	45.00	Phi[11] =	60.00	Psi[27] =	18.43	Phi[27] =	300.00
Psi[12] =	18.43	Phi[12] =	120.00	Psi[28] =	26.57	Phi[28] =	300.00
Psi[13] =	26.57	Phi[13] =	120.00	Psi[29] =	33.21	Phi[29] =	300.00
Psi[14] =	33.21	Phi[14] =	120.00	Psi[30] =	39.23	Phi[30] =	300.00
Psi[15] =	39.23	Phi[15] =	120.00	Psi[31] =	45.00	Phi[31] =	300.00
Psi[16] =	45.00	Phi[16] =	120.00				

4) The program then asks for the data for the PSD calibration.

Degrees/Channel	=	0.020000
Two Theta zero	=	155.000
Channel number	=	500
First Channel	=	0000
Last Channel	=	1023

Again, these parameters have the same meaning as for the biaxial PSD measurement case.

5) Information for the error estimation are requested.

Include Instrumental Error	:	Y	
Estimate Time	:	Y	
Approximate Peak Position	:	156.000	
PSD Cycling Time	:	5	sec

6) If instrumental error is to be included this information is next requested.

Horizontal Beam Divergence	:	1	Degrees
Sample Displacement	:	0.0010	Inches
Psi Axis Missetting	:	0	Inches

7) The program then asks for the accuracy to which the peaks should be found as for the triaxial step counting case and the errors are reported which may be accepted or recalculated with a new peak accuracy. This is shown below.

```
                Counting Error  Instrumental Error
Stress 11          9.29093          5.53006
Stress 22          9.29093          5.53006
Stress 33          5.48515          4.45560
Stress 12          3.53859          0.00000
Stress 13          1.34624          0.00000
Stress 23          1.34624          0.00000


  Is this OK (Y/N)?
```

8) The unstressed lattice parameter is requested.

```
Input the unstressed d-spacing:  1.17119
```

9) A message to hit any key to proceed is displayed.

```
Open Shutter, Hit Any Key To Proceed.
```

The program then uses the PSD to measure the peak positions to the desired accuracy and computes the stresses. The output is exactly the same as for the triaxial step counting case.

4 USING THE PROGRAM ELASTIC

The program ELASTIC is based on the program STRESS an hence is very similar to use. When the program is initially run the following initialization screen comes up.

```
        2theta     =    155.000
        omega      =      0.000
        stress     =     23.000

  Goniometer Radius       :  6.500  inch
  Detector Deadtime       :  1.5E-06
  Wavelength              :  2.290900
  Load Cell/Strain Gauge  :  L
  Using a PSD             :   true
  Theta/TwoTheta Coupled  :   true
```

```
Input the correct values
Press "End" to continue
```

This is very similar to the initialization screen for the program STRESS. The position of the stress motor is not very important. The program adjusts it based on the load desired and not its position. The "Load Cell/Strain Gauge" option is used to indicate how the program should determine the load applied to the sample.

The main menu is next presented to the operator.

```
Elastic Constants Measurement Program:  Version 1.00
R.A. Winholtz, (c) 1990 Northwestern University

F1 Elastic Constants Measurement
F2 Align Sample
F3 Diffractometer Control
F4 Quit
```

"Elastic Constants Measurement" will procede with making an x-ray elastic constants measurement and is the main portion of the program. The "Align Sample" option does a Nelson-Riley alignment to determine the sample displacement. This works exactly like the one in the program STRESS. Care should be taken in using this as the hardware for applying loads to the sample may get in the way at low two theta values and bind up the diffractometer. Be sure to check the safe limits of motion before using this option. "Diffractometer Control" presents the same menu for controlling the diffractometer system as the one in the program stress.

When the "Elastic Constants Measurement" option is selected the program goes through the following sequence of data input:

1) As usual the program first requests an output file. The options requested and input data are stored here along with the data and final results.

```
Give an output file name:  test.dat
```

2) The experimental parameters are next requested as shown below.

```
INPUT DATA FOR ELASTIC CONSTANTS MEASUREMENT

Sample Width (cm)                 :  1.000
Sample Thickness (cm)             :  0.100
Number of Tilts                   :  6
Number of Loads                   :  4
Approximate Peak Position         :  156.000
Subtract Background               :  Y
Scattering Factor Correction      :  N
Oscillate Sample                  :  N
Peak Shift Correction             :  N
Include Instrumental Error        :  Y
Estimate Time For Measurement     :  Y
```

The sample dimensions in centimeters are needed to compute the stress on the sample if a load cell is being used. The number of tilts is the number of psi tilts to be used in making the d vs. $\sin^2$ psi plots. The approximate peak position is needed to do the error estimations. The other parameters are the same as they are in the STRESS program. If a strain gauge is being used to measure the stress on the sample the program asks for the conversion factor for the voltage output to strain and the Young's modulus of the sample, as shown, so that the stress may be computed from the voltage output of the strain gauge.

```
Strain/Volts for Strain Gauge  :  +0.000015
Young Modulus for Sample       :  205000    MPa
```

If the instrumental errorw are to be included the program requests the data needed to compute them.

```
Horizontal Beam Divergence :        1  Degrees
Sample Displacement        :   0.0010  Inches
Psi Axis Missetting        :        0  Inches
```

3) The program next asks for the stress values to be applied to the sample. The operator needs to be sure that the stresses will not cause the sample to yield.

```
Stress[1] =  50.0
Stress[2] =  150.0
Stress[3] =  250.0
Stress[4] =  350.0
```

4) The program then asks for the psi tilts to use. Because the hardware to apply the stresses may interfere with the diffractometer be sure the psi values given are allowed.

```
Psi[1] =  0.00
Psi[2] = 18.43
Psi[3] = 26.57
Psi[4] = 33.21
Psi[5] = 39.23
Psi[6] = 45.00
```

5) If a PSD is being used the parameters needed for the MCA operation are requested.

```
Degrees/Channel  =   0.020000
Two Theta zero   =   155.000
Channel number   =   500
First Channel    =   0000
Last Channel     =   1023
PSD Cycling Time =   5
```

Otherwise, if step counting is being done the parameters for locating peaks by step counting are requested.

```
Number of fitting points  :   7
Initial Two-Theta         :   155.0
First step increment      :   0.20
Second step increment     :   0.10
First Counts (1000)       :   1000
Second Counts (5000)      :   5000
Background angle          :   145.0
```

Both of these screens are the same as those described in the STRESS program.

6) The program next needs input on the operator's desired errors in the measurement. The program allows one to specify the error in either x-ray elastic constant or in the precision in locating the peaks. The operator must choose which error to enter as shown below.

```
How do you want to specify the Error?

     [1] Error in S1
     [2] Error in S2/2
     [3] Error in Peak Positions
```

After making this choice the computer requests the error in the quantity desired. For example:

```
What error do you want in TwoTheta? 0.01
```

The program then calculates the error in all three quantities based on the error in the input quantity and presents them to the operator for approval or disapproval.

```
      Total Error in S1      =  9.2E-08 1/MPa
    Counting Error in S1     =  8.5E-08 1/MPa
  Instrumental Error in S1   =  3.6E-08 1/MPa

      Total Error in S2/2    =  2.8E-07 1/MPa
    Counting Error in S2/2   =  2.8E-07 1/MPa
  Instrumental Error in S2/2 =  2.7E-08 1/MPa

Counting Error in Two Theta  =  1.0E-02 Degrees
```

```
Do you want to accept these or not (Y/N)?
```

If the operator accepts these errors the program proceeds and will find all the peak positions to the indicated precision which will give the indicated errors in the x-ray elastic constants. If the proposed errors are rejected the whole process is repeated. If the time for the measurement was to be estimated, the operator will be given another chance to change the desired errors after an initial prescan of the data by the program. The procedure is again exactly repeated.

7) The operator is next instructed to remove the dead motion in the load motor. The operator should also adjust the stress motor step size so that when the program iterates to a stress value it does not take an inordinate amount of time and also does not overshoot. The screen for this process is shown below.

```
Remove the dead motion in the stress motor
by using the up and down arrows to put a
small stress on the sample. Use the left
and right arrows to adjust the Stress motor
step size to a value that works well.
```

```
Stress Motor step size =   0.50  turns
Stress Motor position  =  23.00  turns
Load =          218  Pounds
Stress =     96.98  MPa
```

```
Hit ESCAPE to proceed.
```

The current step size for the stress motor is displayed as is the stress on the sample. The operator should select a step size that increases the load in a well behaved fashion. The operator should also run the stress up to the maximum value and back down. This will set the grips so that stress relaxation during the measurement will be minimized. As indicated on the screen the arrow keys control the stress motor step size and its position.

8) The program then asks for the tolerance in the applied loads as shown.

```
Input the Tolerance in the applied stresses (MPa):  10
```

The operator should have developed a feel for this in setting the stress motor step size. When the program sets the loads it increases (decreases) the load until the stress is within the tolerance of the desired value. The step size for the stress motor will be adjusted if the desired stress is overshot. It will continue to adjust until the stress is achieved to the desired tolerance. For the next stress the original stress motor step size will be initially used.

9) Finally, the operator is instructed to hit a key to proceed.

```
Open Shutter, Hit Any Key To Proceed.
```

The program then proceeds to make the measurement. As it finds the peak positions it writes them in the output file. The final output is written to the output file and presented as shown below.

```
S1   = -1.25E-06 +/-  8.03E-08
Counting Error     =  7.16E-08
Instrumental Error =  3.63E-08

S2/2 =  5.77E-06 +/-  2.38E-07
Counting Error     =  2.37E-07
Instrumental Error =  2.70E-08
```

5 USING THE COMMAND LINE PROGRAMS

The programs INITPOS, MOVETO, and SCANTTH run from the DOS prompt using parameters input on the command line. INITPOS takes no parameters. It simply reads the CURR.POS file and allows the user to change the current positions if necessary. It is meant to start off a batch file.

MOVETO moves the four diffractometer angles to positions input on the command line. For example, if the command

MOVETO 153.27 34.59 0.0 60.0

is issued at the dos prompt the program will move two theta to 153.27, omega to 34.59, chi to 0.0, and phi to 60.0. The program then writes the angles to the file CURR.POS and finishes.

The program SCANTTH does a two theta scan and records the data in a file. If the command

SCANTTH 154 158 0.1 5 DATA1.DAT

is issued the computer will record a two theta step scan in the file DATA1.DAT. The two theta scan begins at 154 and goes to 158 in 0.1 degree increments. At each point counts are accumulated for 5 seconds. The data is stored in the file DATA1.DAT in three columns: the two theta angle, the counts accumulated, and the time counted.

These programs are useful for creating batch file programs that will accumulate data that may be processed separately. For example assume the file COLLECT.BAT contains the following:

```
INITPOS
MOVETO 153 0.0 0.0 0.0
SCANTTH 153 158 0.1 5 DATA1.DAT
MOVETO 153 18.43 0.0 0.0
SCANTTH 153 158 0.1 5 DATA2.DAT
MOVETO 153 26.57 0.0 0.0
SCANTTH 153 158 0.1 5 DATA3.DAT
MOVETO 153 33.21 0.0 0.0
SCANTTH 153 158 0.1 5 DATA4.DAT
MOVETO 153 39.23 0.0 0.0
SCANTTH 153 158 0.1 5 DATA5.DAT
MOVETO 153 45.00 0.0 0.0
SCANTTH 153 158 0.1 5 DATA6.DAT
```

If this batch file is executed the computer will ask the operator to give the current angular positions of the diffractometer. It will then proceed to move the diffractometer to the desired angular settings and then make a two theta scan. This is repeated six times. In this example the omega axis is moved to a different position for each two theta scan. This batch program could be used to collect data on a sample for use in making a biaxial stress measurement. The data for peaks at different psi tilts would be contained in the data files indicated in the batch file. The data in these files may be used to locate the diffraction peak positions at the different psi tilts. From this data the biaxial stress in the sample may be computed. Data may also be collected for triaxial stress measurements, elastic constants measurements, or other applications using different batch files.

The programs PEAKFIT, BSTRESS, TRIAXIAL, and MICRO can be used to analyze data collected from SCANTTH. PEAKFIT will read data files created by SCANTTH and determine the peak position. It will fit the top 85 percent of a diffraction peak to a parabola to determine the peak or fit the entire diffraction peak to a nonlinear peak profile.

The peak positions determined with PEAKFIT may then be used by BSTRESS, TRIAXIAL, or MICRO to compute the stresses within the sample. BSTRESS uses the peak positions, the sample tilts, and an elastic constant to determine the biaxial stress in the sample along the tilting direction by the sin squared psi method. TRIAXIAL uses the peak positions, the sample tilts, and two elastic constants to determine the entire stress tensor in the sample. MICRO uses the same information as TRIAXIAL but for two phases in the sample and their volume fractions to determine the macro-stress tensor in the sample and the micro-stress tensors in each phase. It also presents the deviatoric components of the stress tensors which do not have an error associated with them due any error in the unstressed lattice parameters.

6 How to Modify for Other Sytems

All the hardware interfaces are contained in the unit HARDWARE for the programs STRESS, INITPOS, MOVETO, and SCANTTH and in the unit HARDWARE2 for the program ELASTIC. To adapt the software for other systems changes to the software can be confined to these two units. To make the software compatible with other hardware the following procedures will need to be replaced with new ones written for the new hardware:

```
procedure Move(MotorNumber;NewPosition;Error);
procedure CheckMotors;
function  MotorsBusy;
procedure ConstCount(Count,Time);
procedure ConstTime(Time,Count);
procedure StartMCA;
procedure StopMCA;
procedure ReadMCA;
procedure ClearMCA;
procedure TImeCount(Time);
procedure DetermineAppliedStress(stress);
```

The procedure Move moves a motor to its new position and then updates its current position in the global array CurrentPosition. It must correctly handle coupled and uncoupled diffractometers based on the global variable ThetaTwoThetaCoupled. The procedure CheckMotors simply checks to see if the ESC key has been pressed in which case it will stop the motors. The function MotorsBusy returns true if the motors are still moving and false if they have finished.

The procedures ConstCount and ConstTime both use the counter timer card to determine the number of counts in an amount of time. ConstCount returns the time to achieve a given number of counts, while ConstTime returns the number of counts in a given amount of time.

StartMCA, StopMCA, and ClearMCA are self descriptive. The procedure ReadMCA reads counts in the channels of the MCA and

ClearMCA resets the counts in every channel to zero. The procedure TimeCount turns the MCA on for "Time" seconds to accumulate counts from the PSD. When finished it increments the global variable GL_MCAData.TimeCounted by this same amount of time.

The procedure DetermineAppliedStress determines the stress in MPa on the sample from the load and sample dimensions in the case of using a load cell and from the strain gauge output and the sample's Youngs modulus in the case of using a strain gauge.

Further information on possible modifications needed to port the programs is in the source code. In making any modifications to the code one will find the Turbo Debugger very useful. The debugger will allow you to execute lines of code one at a time which is very effective in tracking down errors.

7 EXAMPLE OUTPUT FILES

The first example is the output file for a biaxial stress measurement using a PSD on a ground steel specemen.

```
Biaxial Stress Measurement
Start Time = 12:10:28
Start Date = 6-16-1990
Omega Goniometry
Subtract Background = Yes
Specify Error = Yes
Scattering Factor Correction = No
Number of Tilts = 6
S2/2 = 5.7700000000E-06
Sample Oscillation = No
PSD Degrees/Channel = 3.92000000E-02
PSD Two Theta Not = 156.000
PSD Channel Not = 2.7E+02
PSD First Channel = 75
PSD Last Channel = 1023
Include Instrumental Error = Yes
Estimate Time = Yes
Desired Error = 20.0
Approximate Peak = 156.000
PSD Cycling Time = 5.0000000000E+00
Psi = 0.000
Background Intensity = 0.00
```

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
153.609	81.27	2.328	42.816	15.000
153.648	80.13	2.311	42.212	15.000
153.687	80.27	2.313	42.276	15.000
153.726	80.53	2.317	42.411	15.000
153.766	80.60	2.318	42.440	15.000
153.805	83.67	2.362	44.052	15.000
153.844	84.73	2.377	44.608	15.000
153.883	82.93	2.351	43.653	15.000
153.922	86.53	2.402	45.545	15.000
153.962	94.33	2.508	49.652	15.000
154.001	89.73	2.446	47.219	15.000
154.040	91.60	2.471	48.197	15.000
154.079	93.73	2.500	49.315	15.000
154.118	94.33	2.508	49.624	15.000
154.158	92.07	2.477	48.423	15.000
154.197	91.20	2.466	47.959	15.000
154.236	93.07	2.491	48.936	15.000

154.275	96.07	2.531	50.510	15.000
154.314	97.53	2.550	51.276	15.000
154.354	100.93	2.594	53.060	15.000
154.393	90.60	2.458	47.610	15.000
154.432	96.73	2.539	50.833	15.000
154.471	95.27	2.520	50.054	15.000
154.510	102.73	2.617	53.978	15.000
154.550	96.00	2.530	50.426	15.000
154.589	93.60	2.498	49.156	15.000
154.628	95.80	2.527	50.307	15.000
154.667	98.07	2.557	51.493	15.000
154.706	98.27	2.560	51.591	15.000
154.746	92.20	2.479	48.392	15.000
154.785	88.27	2.426	46.317	15.000
154.824	89.67	2.445	47.047	15.000
154.863	86.27	2.398	45.254	15.000
154.902	88.33	2.427	46.334	15.000
154.942	86.00	2.394	45.101	15.000
154.981	86.60	2.403	45.410	15.000
155.020	88.47	2.429	46.385	15.000
155.059	86.60	2.403	45.398	15.000
155.098	86.33	2.399	45.252	15.000
155.138	85.47	2.387	44.790	15.000
155.177	87.13	2.410	45.659	15.000
155.216	84.20	2.369	44.113	15.000
155.255	84.40	2.372	44.212	15.000
155.294	82.47	2.345	43.192	15.000
155.334	79.33	2.300	41.542	15.000
155.373	80.87	2.322	42.341	15.000
155.412	79.73	2.306	41.741	15.000
155.451	78.93	2.294	41.316	15.000
155.490	81.20	2.327	42.499	15.000
155.608	81.33	2.329	42.552	15.000 Peak = 154.50885

STD(Peak) = 0.01708

Psi = 18.430

Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
153.805	65.85	1.815	37.589	20.000
153.844	66.90	1.829	38.179	20.000
153.883	68.45	1.850	39.055	20.000
153.922	66.60	1.825	37.987	20.000
153.962	71.30	1.888	40.662	20.000
154.001	69.70	1.867	39.737	20.000
154.040	70.35	1.875	40.098	20.000
154.079	71.25	1.887	40.601	20.000
154.158	71.95	1.897	40.978	20.000
154.197	76.90	1.961	43.792	20.000
154.236	76.40	1.954	43.495	20.000
154.275	77.55	1.969	44.140	20.000
154.314	77.80	1.972	44.270	20.000
154.354	80.00	2.000	45.513	20.000
154.393	79.85	1.998	45.415	20.000
154.432	80.80	2.010	45.945	20.000
154.471	85.70	2.070	48.725	20.000
154.510	81.35	2.017	46.233	20.000
154.550	83.15	2.039	47.246	20.000
154.589	86.20	2.076	48.971	20.000
154.628	82.15	2.027	46.652	20.000
154.667	84.40	2.054	47.920	20.000
154.706	80.85	2.011	45.887	20.000
154.746	81.30	2.016	46.131	20.000
154.785	84.60	2.057	47.995	20.000
154.824	75.95	1.949	43.065	20.000
154.863	78.80	1.985	44.673	20.000
154.902	80.35	2.004	45.542	20.000
154.942	79.85	1.998	45.246	20.000
154.981	78.50	1.981	44.467	20.000
155.020	77.20	1.965	43.718	20.000
155.059	76.70	1.958	43 422	20.000
155.098	75.10	1.938	42.503	20.000

155.138	79.45	1.993	44.959	20.000
155.177	78.30	1.979	44.295	20.000
155.216	77.05	1.963	43.575	20.000
155.255	80.35	2.004	45.434	20.000
155.294	74.50	1.930	42.107	20.000
155.334	77.45	1.968	43.767	20.000
155.373	75.15	1.938	42.453	20.000
155.412	71.90	1.896	40.602	20.000
155.451	75.30	1.940	42.516	20.000
155.490	69.35	1.862	39.139	20.000
155.530	70.25	1.874	39.637	20.000
155.569	67.65	1.839	38.157	20.000
155.608	70.75	1.881	39.899	20.000
155.647	68.20	1.847	38.448	20.000
155.726	67.60	1.838	38.089	20.000
155.765	67.50	1.837	38.023	20.000 Peak = 154.75122

STD(Peak) = 0.01399

Psi = 26.570

Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
153.805	67.90	1.843	40.464	20.000
153.844	68.15	1.846	40.600	20.000
153.883	69.20	1.860	41.212	20.000
153.922	67.50	1.837	40.184	20.000
154.001	69.00	1.857	41.050	20.000
154.040	68.40	1.849	40.679	20.000
154.079	71.30	1.888	42.393	20.000
154.118	70.80	1.881	42.080	20.000
154.158	76.15	1.951	45.252	20.000
154.197	74.95	1.936	44.522	20.000
154.236	78.30	1.979	46.501	20.000
154.275	77.15	1.964	45.800	20.000
154.314	77.05	1.963	45.725	20.000
154.354	80.00	2.000	47.464	20.000
154.393	74.60	1.931	44.238	20.000
154.432	81.20	2.015	48.145	20.000
154.471	81.15	2.014	48.098	20.000
154.510	82.50	2.031	48.884	20.000
154.550	81.25	2.016	48.125	20.000
154.589	85.75	2.071	50.780	20.000
154.628	81.70	2.021	48.359	20.000
154.667	82.65	2.033	48.906	20.000
154.706	84.70	2.058	50.105	20.000
154.746	84.60	2.057	50.029	20.000
154.785	82.65	2.033	48.857	20.000
154.824	79.90	1.999	47.211	20.000
154.863	83.85	2.048	49.534	20.000
154.902	79.45	1.993	46.913	20.000
154.942	81.85	2.023	48.317	20.000
154.981	88.05	2.098	51.969	20.000
155.020	81.90	2.024	48.314	20.000
155.059	80.90	2.011	47.706	20.000
155.098	79.95	1.999	47.129	20.000
155.138	83.95	2.049	49.476	20.000
155.177	82.40	2.030	48.544	20.000
155.216	81.95	2.024	48.262	20.000
155.255	78.15	1.977	46.003	20.000
155.294	78.10	1.976	45.958	20.000
155.334	79.15	1.989	46.562	20.000
155.373	81.35	2.017	47.843	20.000
155.412	78.40	1.980	46.089	20.000
155.451	77.70	1.971	45.661	20.000
155.490	78.75	1.984	46.264	20.000
155.530	75.70	1.946	44.453	20.000
155.569	74.00	1.924	43.438	20.000
155.608	71.20	1.887	41.777	20.000
155.686	71.10	1.885	41.691	20.000
155.726	70.25	1.874	41.177	20.000
155.765	67.55	1.838	39.578	20.000 Peak = 154.83337

STD(Peak) = 0.01501

Psi = 33.210
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
153.883	66.00	2.098	40.943	15.000
153.922	66.93	2.112	41.506	15.000
153.962	64.27	2.070	39.833	15.000
154.001	66.67	2.108	41.305	15.000
154.040	66.27	2.102	41.040	15.000
154.079	72.73	2.202	45.033	15.000
154.118	69.67	2.155	43.113	15.000
154.158	70.80	2.173	43.797	15.000
154.197	74.20	2.224	45.885	15.000
154.236	72.20	2.194	44.628	15.000
154.275	70.13	2.162	43.330	15.000
154.314	71.93	2.190	44.425	15.000
154.354	76.60	2.260	47.293	15.000
154.393	75.67	2.246	46.696	15.000
154.432	77.13	2.268	47.583	15.000
154.471	77.67	2.275	47.893	15.000
154.510	76.67	2.261	47.256	15.000
154.550	76.40	2.257	47.071	15.000
154.589	81.60	2.332	50.260	15.000
154.628	79.47	2.302	48.924	15.000
154.667	81.07	2.325	49.890	15.000
154.706	84.13	2.368	51.759	15.000
154.746	80.87	2.322	49.726	15.000
154.785	80.13	2.311	49.253	15.000
154.824	81.87	2.336	50.300	15.000
154.863	80.20	2.312	49.254	15.000
154.902	83.20	2.355	51.079	15.000
154.942	81.07	2.325	49.746	15.000
154.981	84.47	2.373	51.815	15.000
155.020	83.67	2.362	51.302	15.000
155.059	80.40	2.315	49.276	15.000
155.098	83.60	2.361	51.219	15.000
155.138	82.33	2.343	50.421	15.000
155.177	81.00	2.324	49.583	15.000
155.216	82.60	2.347	50.543	15.000
155.255	79.13	2.297	48.399	15.000
155.294	78.67	2.290	48.093	15.000
155.334	83.67	2.362	51.135	15.000
155.373	79.13	2.297	48.339	15.000
155.412	78.80	2.292	48.116	15.000
155.451	80.67	2.319	49.237	15.000
155.490	76.33	2.256	46.569	15.000
155.530	76.20	2.254	46.469	15.000
155.569	70.80	2.173	43.153	15.000
155.608	80.13	2.311	48.832	15.000
155.647	72.47	2.198	44.134	15.000
155.686	73.13	2.208	44.523	15.000
155.726	73.33	2.211	44.627	15.000
155.765	72.40	2.197	44.040	15.000
155.804	67.87	2.127	41.261	15.000
155.843	70.20	2.163	42.665	15.000
155.882	70.93	2.175	43.094	15.000
155.922	64.93	2.081	39.428	15.000
155.961	67.53	2.122	40.992	15.000
156.000	67.67	2.124	41.057	15.000
156.039	65.13	2.084	39.501	15.000
156.078	65.40	2.088	39.647	15.000

Peak = 154.95504
STD(Peak) = 0.01464

Psi = 39.230
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
154.236	55.35	1.664	35.771	20.000
154.275	54.60	1.652	35.267	20.000
154.354	57.95	1.702	37.398	20.000
154.432	59.00	1.718	38.038	20.000
154.471	58.00	1.703	37.374	20.000
154.510	56.45	1.680	36.355	20.000

154.550	59.60	1.726	38.368	20.000
154.589	61.05	1.747	39.284	20.000
154.628	59.95	1.731	38.556	20.000
154.667	61.75	1.757	39.696	20.000
154.706	63.20	1.778	40.610	20.000
154.746	65.15	1.805	41.844	20.000
154.785	64.70	1.799	41.534	20.000
154.824	66.70	1.826	42.799	20.000
154.863	64.00	1.789	41.043	20.000
154.902	66.00	1.817	42.307	20.000
154.942	66.10	1.818	42.351	20.000
154.981	67.35	1.835	43.132	20.000
155.020	66.65	1.826	42.662	20.000
155.059	68.65	1.853	43.923	20.000
155.098	63.25	1.778	40.441	20.000
155.138	70.65	1.879	45.160	20.000
155.177	67.85	1.842	43.346	20.000
155.216	67.45	1.836	43.068	20.000
155.255	69.00	1.857	44.039	20.000
155.294	69.45	1.863	44.305	20.000
155.334	69.10	1.859	44.059	20.000
155.373	64.55	1.797	41.132	20.000
155.412	69.80	1.868	44.463	20.000
155.451	66.50	1.823	42.336	20.000
155.490	66.25	1.820	42.156	20.000
155.530	67.95	[illegible]	43.218	20.000
155.569	63.75	[illegible]d5	40.522	20.000
155.608	64.55	[illegible].797	41.012	20.000
155.647	65.30	1.807	41.469	20.000
155.686	66.25	1.820	42.053	20.000
155.726	66.65	1.826	42.287	20.000
155.765	60.15	1.734	38.137	20.000
155.804	62.80	1.772	39.800	20.000
155.843	58.20	1.706	36.862	20.000
155.882	58.70	1.713	37.161	20.000
155.922	62.20	1.764	39.362	20.000
155.961	61.20	1.749	38.709	20.000
156.000	58.55	1.711	37.012	20.000
156.039	58.35	1.708	36.868	20.000
156.078	56.95	1.687	35.964	20.000
156.118	60.20	1.735	38.002	20.000
156.157	58.15	1.705	36.688	20.000
156.196	56.50	1.681	35.628	20.000 Peak = 155.22221

STD(Peak) = 0.01648

Psi = 45.000
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
154.393	54.90	1.657	37.320	20.000
154.550	56.45	1.680	38.283	20.000
154.589	57.60	1.697	39.040	20.000
154.628	56.45	1.680	38.237	20.000
154.667	59.85	1.730	40.519	20.000
154.706	60.55	1.740	40.970	20.000
154.746	59.80	1.729	40.437	20.000
154.785	64.30	1.793	43.460	20.000
154.824	62.35	1.766	42.114	20.000
154.863	61.00	1.746	41.176	20.000
154.902	59.80	1.729	40.340	20.000
154.942	62.85	1.773	42.376	20.000
154.981	65.40	1.808	44.072	20.000
155.020	64.50	1.796	43.439	20.000
155.059	67.55	1.838	45.470	20.000
155.098	66.90	1.829	45.005	20.000
155.138	64.40	1.794	43.294	20.000
155.177	67.35	1.835	45.254	20.000
155.216	66.75	1.827	44.823	20.000
155.255	67.85	1.842	45.536	20.000
155.294	69.05	1.858	46.316	20.000
155.334	68.15	1.846	45.684	20.000
155.373	65.95	1.816	44.180	20.000

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 155.412      68.80       1.855       46.066       20.000
 155.451      70.05       1.871       46.877       20.000
 155.490      70.25       1.874       46.983       20.000
 155.530      65.80       1.814       43.975       20.000
 155.569      64.45       1.795       43.046       20.000
 155.608      66.35       1.821       44.291       20.000
 155.647      63.85       1.787       42.594       20.000
 155.686      66.00       1.817       44.005       20.000
 155.726      65.05       1.803       43.345       20.000
 155.765      66.25       1.820       44.120       20.000
 155.804      64.25       1.792       42.760       20.000
 155.843      65.15       1.805       43.335       20.000
 155.882      60.50       1.739       40.213       20.000
 155.922      59.85       1.730       39.757       20.000
 155.961      60.35       1.737       40.066       20.000
 156.000      62.50       1.768       41.472       20.000
 156.039      64.30       1.793       42.643       20.000
 156.078      59.30       1.722       39.298       20.000
 156.118      56.75       1.684       37.584       20.000
 156.157      55.75       1.670       36.899       20.000
 156.196      58.90       1.716       38.965       20.000
 156.235      59.85       1.730       39.571       20.000
 156.274      57.45       1.695       37.959       20.000
 156.314      55.20       1.661       36.449       20.000
 156.353      55.80       1.670       36.824       20.000 Peak      = 155.36261
STD(Peak) = 0.01645


Stress =    -548.74 +/-   18.58962
Counting Error     =    18.39496
Instrumental Error =     2.68316

slope    = -3.71817E-03   STD(slope) =  1.24642E-04 intecept =  1.17433E+00   STD(inter) =  3.70485E-05 q =
1.14080E-04

   Psi         Peak          STD(Peak)
 0.000       154.5089        0.01708
18.430       154.7512        0.01399
26.570       154.8334        0.01501
33.210       154.9550        0.01464
39.230       155.2222        0.01648
45.000       155.3626        0.01645
```

The following is an example output file for a triaxial stress measurement done by step counting. The sample is a 1080 steel sample quenched and tempered and surface ground along the S_1 axis.

```
Triaxial Stress Measurement
Start Time = 10:42:48
Start Date = 12-13-1989
Omega Goniometry
Subtract Background = Yes
Specify Error = Yes
Scattering Factor Correction = No
Number of Tilts = 31
S2/2 =  5.7700000000E-06
S1   = -1.2500000000E-06
Sample Oscillation = No
Points for parabola fitting =  7
Initial Two Theta           = 155.000
First Step                  = 0.200
Second Step                 = 0.100
First Counts                =  1000
Second Counts               =  5000
```

Background Angle = 145.000
Include Instrumental Error = Yes
Estimate Time = Yes
Approximate Peak = 156.000
Phi = 0.000
Psi = 0.000
Background Intensity = 5128.21

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.725	9831.08	37.771	5712.413	6.891
156.155	10170.54	39.075	5901.110	6.661
156.580	10026.05	38.520	5809.071	6.757
157.010	9414.40	36.170	5447.020	7.196
157.435	8699.88	33.425	5026.732	7.787
157.865	7971.99	30.628	4599.890	8.498
158.290	7238.59	27.811	4171.184	9.359

Peak = 155.89133
STD(Peak) = 0.04687

Phi = 0.000
Psi = 18.430
Background Intensity = 4694.84

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.740	9395.35	82.632	5387.032	1.376
156.015	9691.15	85.233	5546.489	1.334
156.290	9846.15	86.597	5624.964	1.313
156.570	9808.80	86.268	5593.322	1.318
156.845	9540.96	83.912	5430.822	1.355
157.120	9034.24	79.456	5133.213	1.431
157.395	8572.94	75.399	4862.463	1.508

Peak = 156.31671
STD(Peak) = 0.03323

Phi = 0.000
Psi = 26.570
Background Intensity = 4608.29

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.405	8224.67	190.347	4837.491	0.227
155.765	9151.96	211.808	5366.391	0.204
156.125	9930.85	229.834	5805.370	0.188
156.490	9525.51	220.453	5551.338	0.196
156.850	9673.58	223.880	5620.692	0.193
157.210	9063.11	209.751	5250.276	0.206
157.570	8012.88	185.445	4628.122	0.233

Peak = 156.42724
STD(Peak) = 0.03592

Phi = 0.000
Psi = 33.210
Background Intensity = 4201.68

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.720	8640.05	106.344	5301.995	0.764
155.970	9245.10	113.791	5658.658	0.714
156.215	9193.59	113.157	5612.981	0.718
156.465	9497.84	116.901	5783.919	0.695
156.715	9297.18	114.432	5647.325	0.710
156.960	9142.66	112.530	5539.685	0.722
157.210	8884.25	109.349	5369.547	0.743

Peak = 156.46745
STD(Peak) = 0.03773

Phi = 0.000
Psi = 39.230
Background Intensity = 4132.23

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.415	7756.33	82.305	4996.841	1.145
155.715	8110.50	86.063	5205.498	1.095
156.015	8828.03	93.677	5644.983	1.006
156.320	9165.12	97.254	5838.527	0.969
156.620	9053.01	96.064	5745.929	0.981
156.920	8810.52	93.491	5571.598	1.008
157.220	8418.01	89.326	5304.053	1.055

Peak = 156.45099
STD(Peak) = 0.02805

Phi = 0.000
Psi = 45.000
Background Intensity = 3745.32

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.540	7365.08	170.958	4925.418	0.252
155.910	8000.00	185.695	5320.367	0.232
156.275	8474.89	196.718	5605.585	0.219
156.645	8880.38	206.131	5841.696	0.209
157.015	8248.89	191.473	5396.847	0.225
157.380	7669.42	178.022	4991.065	0.242
157.750	7483.87	173.715	4844.268	0.248

Peak = 156.56388
STD(Peak) = 0.04656

Phi = 60.000
Psi = 18.430
Background Intensity = 4545.45

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.720	9966.99	94.293	5700.256	1.121
156.045	10442.06	98.787	5959.063	1.070
156.365	10550.52	99.813	6008.252	1.059
156.690	10111.31	95.658	5745.873	1.105
157.015	9412.81	89.050	5337.625	1.187
157.335	8825.43	83.493	4994.200	1.266
157.660	8161.43	77.211	4608.817	1.369

Peak = 156.15142
STD(Peak) = 0.05315

Phi = 60.000
Psi = 26.570
Background Intensity = 4385.96

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.540	9188.82	133.060	5422.012	0.519
155.830	9976.99	144.473	5872.563	0.478
156.120	10082.45	146.000	5920.085	0.473
156.410	10435.45	151.111	6112.405	0.457
156.700	9853.31	142.682	5757.421	0.484
156.990	9481.11	137.292	5526.578	0.503
157.280	8847.87	128.122	5145.081	0.539

Peak = 156.30134
STD(Peak) = 0.02916

Phi = 60.000
Psi = 33.210
Background Intensity = 4048.58

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.370	8222.22	171.669	5031.130	0.279
155.685	9031.50	188.566	5508.272	0.254
156.000	9325.20	194.698	5668.935	0.246
156.315	9887.93	206.447	5991.617	0.232
156.630	9558.33	199.566	5773.303	0.240
156.945	8857.14	184.926	5332.704	0.259
157.260	8281.59	172.909	4970.353	0.277

Peak = 156.29014
STD(Peak) = 0.03295

Phi = 60.000
Psi = 39.230
Background Intensity = 4291.85

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.465	8048.65	147.489	5135.831	0.370
155.745	8810.65	161.453	5602.483	0.338
156.020	9248.45	169.475	5860.851	0.322
156.300	9394.32	172.148	5932.769	0.317
156.575	9796.05	179.510	6165.632	0.304
156.855	9107.03	166.884	5712.404	0.327
157.130	8631.88	158.177	5396.312	0.345

Peak = 156.37270

STD(Peak) = 0.03433

Phi = 60.000
Psi = 45.000
Background Intensity = 3891.05

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.535	7522.22	129.291	5042.484	0.450
155.870	8505.03	146.183	5672.667	0.398
156.205	9026.67	155.149	5990.549	0.375
156.540	9026.67	155.149	5960.851	0.375
156.875	8955.03	153.917	5884.417	0.378
157.210	8462.50	145.452	5533.565	0.400
157.545	7658.37	131.631	4983.408	0.442

Peak = 156.51248
STD(Peak) = 0.02544

Phi = 120.000
Psi = 18.430
Background Intensity = 4587.16

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.630	10555.16	73.254	6129.937	1.967
155.960	10967.78	76.117	6355.583	1.893
156.295	11020.17	76.481	6371.811	1.884
156.625	10680.04	74.120	6161.779	1.944
156.955	9886.67	68.614	5691.782	2.100
157.290	9066.38	62.922	5208.225	2.290
157.620	8222.57	57.065	4713.486	2.525

Peak = 156.06533
STD(Peak) = 0.03553

Phi = 120.000
Psi = 26.570
Background Intensity = 4405.29

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.195	9367.19	270.520	5513.873	0.128
155.480	9747.97	281.517	5724.019	0.123
155.760	10336.21	298.505	6054.965	0.116
156.045	11205.61	323.613	6548.416	0.107
156.330	10705.36	309.166	6241.056	0.112
156.610	11101.85	320.616	6457.020	0.108
156.895	9515.87	274.814	5521.442	0.126

Peak = 156.12363
STD(Peak) = 0.05128

Phi = 120.000
Psi = 33.210
Background Intensity = 4166.67

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.380	9668.20	211.078	5913.556	0.217
155.640	10086.54	220.211	6152.792	0.208
155.900	10284.31	224.529	6256.593	0.204
156.155	10284.31	224.529	6240.196	0.204
156.415	10334.98	225.635	6254.258	0.203
156.675	10135.27	221.275	6117.168	0.207
156.935	9943.13	217.080	5985.394	0.211

Peak = 156.17703
STD(Peak) = 0.09590

Phi = 120.000
Psi = 39.230
Background Intensity = 4081.63

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.470	8855.49	226.247	5638.040	0.173
155.765	9757.96	249.304	6189.827	0.157
156.060	9635.22	246.168	6089.668	0.159
156.360	9757.96	249.304	6144.486	0.157
156.655	9635.22	246.168	6045.302	0.159
156.950	9119.05	232.981	5700.912	0.168
157.245	8804.60	224.947	5484.682	0.174

Peak = 156.24162
STD(Peak) = 0.06544

Phi = 120.000
Psi = 45.000
Background Intensity = 3906.25

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.090	7516.88	70.532	5134.692	1.511
155.405	8425.82	79.061	5728.155	1.348
155.715	8936.27	83.850	6046.862	1.271
156.030	9480.80	88.960	6385.126	1.198
156.345	9601.01	90.088	6435.833	1.183
156.655	9302.21	87.284	6206.996	1.221
156.970	8880.38	83.326	5898.132	1.279

Peak = 156.24906
STD(Peak) = 0.02549

Phi = 180.000
Psi = 18.430
Background Intensity = 4716.98

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.230	10154.28	137.383	5776.152	0.538
155.550	10628.40	143.798	6032.881	0.514
155.865	11240.74	152.083	6367.061	0.486
156.185	10904.19	147.529	6163.345	0.501
156.505	10860.83	146.943	6125.918	0.503
156.820	10249.53	138.672	5769.221	0.533
157.140	9517.42	128.767	5346.008	0.574

Peak = 156.03435
STD(Peak) = 0.03353

Phi = 180.000
Psi = 26.570
Background Intensity = 4310.34

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.245	9968.18	212.861	5873.895	0.220
155.555	11131.98	237.713	6542.299	0.197
155.865	10965.00	234.147	6427.187	0.200
156.175	11131.98	237.713	6507.971	0.197
156.480	10697.56	228.436	6237.975	0.205
156.790	10393.36	221.941	6044.900	0.211
157.100	9292.37	198.430	5390.639	0.236

Peak = 156.01953
STD(Peak) = 0.04419

Phi = 180.000
Psi = 33.210
Background Intensity = 4347.83

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.260	9924.11	210.485	6078.820	0.224
155.525	9924.11	210.485	6062.075	0.224
155.790	10739.13	227.772	6541.942	0.207
156.055	10585.71	224.518	6430.890	0.210
156.320	10244.24	217.275	6206.542	0.217
156.585	10058.82	213.343	6077.738	0.221
156.850	9459.57	200.633	5700.289	0.235

Peak = 155.94257
STD(Peak) = 0.05646

Phi = 180.000
Psi = 39.230
Background Intensity = 3968.25

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.230	9257.49	235.444	5911.837	0.167
155.570	9910.26	252.046	6301.842	0.156
155.910	10038.96	255.320	6356.762	0.154
156.250	10171.05	258.679	6413.412	0.152
156.590	9723.27	247.291	6105.526	0.159
156.930	9040.94	229.937	5653.573	0.171
157.270	8494.51	216.040	5290.028	0.182

Peak = 156.00174
STD(Peak) = 0.07010

Phi = 180.000

Psi = 45.000
Background Intensity = 3875.97

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.210	8457.09	86.055	5751.502	1.142
155.500	9340.43	95.044	6324.427	1.034
155.790	9765.42	99.368	6583.403	0.989
156.080	9865.17	100.383	6621.854	0.979
156.370	9468.63	96.348	6328.319	1.020
156.660	9198.10	93.595	6121.191	1.050
156.950	8569.65	87.201	5678.696	1.127

Peak = 156.03632
STD(Peak) = 0.01711

Phi = 240.000
Psi = 18.430
Background Intensity = 4629.63

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.170	9514.79	237.277	5383.193	0.169
155.545	10649.01	265.562	6009.739	0.151
155.920	11323.94	282.393	6374.679	0.142
156.290	10791.95	269.127	6060.342	0.149
156.665	10720.00	267.333	6005.135	0.150
157.040	9458.82	235.882	5285.720	0.170
157.415	8691.89	216.756	4845.392	0.185

Peak = 156.10749
STD(Peak) = 0.04509

Phi = 240.000
Psi = 26.570
Background Intensity = 4255.32

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.150	9112.53	139.094	5391.102	0.471
155.450	9776.77	149.233	5769.216	0.439
155.755	10597.53	161.761	6237.303	0.405
156.055	10921.12	166.701	6411.425	0.393
156.355	10519.61	160.572	6160.109	0.408
156.660	9958.24	152.003	5816.487	0.431
156.960	9350.76	142.731	5448.028	0.459

Peak = 156.06598
STD(Peak) = 0.02419

Phi = 240.000
Psi = 33.210
Background Intensity = 4219.41

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.585	9733.62	22.508	8231.201	19.213
155.895	10234.89	23.667	8627.393	18.272
156.210	10361.35	23.960	8705.733	18.049
156.520	10174.20	23.527	8521.428	18.381
156.835	9613.04	22.229	8025.672	19.454
157.145	9011.32	20.838	7499.775	20.753
157.460	8244.23	19.064	6839.658	22.684

Peak = 156.14451
STD(Peak) = 0.00849

Phi = 240.000
Psi = 39.230
Background Intensity = 4081.63

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.645	9462.36	95.570	6086.971	1.036
155.895	9842.37	99.408	6311.794	0.996
156.150	10033.78	101.341	6414.284	0.977
156.405	9754.23	98.518	6216.038	1.005
156.655	9545.28	96.407	6064.280	1.027
156.905	9170.25	92.619	5808.288	1.069
157.160	8721.53	88.087	5507.006	1.124

Peak = 156.13054
STD(Peak) = 0.04081

Phi = 240.000
Psi = 45.000

Background Intensity = 3773.58

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.585	8740.64	62.790	5999.490	2.217
155.875	9280.65	66.669	6342.459	2.088
156.160	9621.65	69.119	6547.564	2.014
156.450	9402.23	67.542	6370.746	2.061
156.735	9179.54	65.943	6193.722	2.111
157.020	8752.48	62.875	5880.905	2.214
157.310	8200.59	58.910	5486.790	2.363

Peak = 156.25555
STD(Peak) = 0.01810

Phi = 300.000
Psi = 18.430
Background Intensity = 4926.11

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.300	8795.92	244.614	4969.766	0.147
155.605	9170.21	255.023	5170.660	0.141
155.910	9946.15	276.602	5596.790	0.130
156.215	10023.26	278.747	5628.795	0.129
156.520	10181.10	283.136	5705.972	0.127
156.825	10261.90	285.383	5739.798	0.126
157.130	9649.25	268.346	5386.439	0.134

Peak = 156.46089
STD(Peak) = 0.11623

Phi = 300.000
Psi = 26.570
Background Intensity = 4608.29

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.585	9066.51	144.204	5341.202	0.436
155.940	9833.33	156.400	5775.488	0.402
156.300	10214.47	162.462	5981.133	0.387
156.655	9594.66	152.604	5601.494	0.412
157.010	9214.45	146.557	5363.636	0.429
157.370	8631.00	137.277	5009.073	0.458
157.725	8100.41	128.838	4687.445	0.488

Peak = 156.30472
STD(Peak) = 0.05593

Phi = 300.000
Psi = 33.210
Background Intensity = 4237.29

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.505	8268.60	184.845	5050.178	0.242
155.825	9013.51	201.498	5486.931	0.222
156.145	9350.47	209.031	5673.322	0.214
156.460	9713.59	217.148	5874.666	0.206
156.780	9528.57	213.012	5744.026	0.210
157.100	9438.68	211.003	5671.441	0.212
157.420	8407.56	187.952	5035.636	0.238

Peak = 156.48381
STD(Peak) = 0.04098

Phi = 300.000
Psi = 39.230
Background Intensity = 4132.23

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.045	7148.85	116.803	4591.076	0.524
155.385	7613.82	124.400	4868.864	0.492
155.725	8533.03	139.418	5433.587	0.439
156.065	9070.22	148.195	5751.364	0.413
156.405	9272.28	151.496	5854.918	0.404
156.745	9092.23	148.555	5717.388	0.412
157.085	8533.03	139.418	5343.606	0.439

Peak = 156.38345
STD(Peak) = 0.05552

Phi = 300.000
Psi = 45.000
Background Intensity = 3937.01

```
Two-Theta   Intensity   STD(Intensity)  Corrected Int     Time
 155.920     8197.82      121.976       5473.018        0.551
 156.205     8720.08      129.746       5796.975        0.518
 156.495     8962.30      133.350       5932.413        0.504
 156.780     8944.55      133.086       5895.814        0.505
 157.065     8620.23      128.261       5658.317        0.524

 157.355     8066.07      120.015       5272.208        0.560
 157.640     7630.07      113.528       4966.640        0.592
Peak       = 156.58139
STD(Peak) = 0.03562

stress =

 -425.24      20.59     -81.60
   20.59    -502.92       6.18
  -81.60       6.18    -289.73


STD(stress) =

   27.99      11.12       4.44
   11.12      29.37       4.14
    4.44       4.14      18.07
```

The final example is an elastic constants measurement using a PSD. The sample is a pearlitic 1080 steel.

```
Start Time = 17: 9: 2
Start Date =  6-17-1990
Horizontal Divergence =  1.0000000000E+00  degrees
Sample Displacement   =  1.0000000000E-03  inches
Psi Axis Missetting   =  0.0000000000E+00  inches
Sample Width      =   1.270 cm
Sample Thichness =   0.153 cm
Number of Tilts  =  6
Number of Loads  =  4
Approximate Peak =  156.000
Subtract Background = Yes
Scattering Factor Correction = No
Sample Oscillation = No
Peak Shift Correction = NO
Include Instrumental Error = Yes
Estimate Time For Measurement = Yes
DesiredStresses:
 2.0000000000E+02
 1.5000000000E+02
 1.0000000000E+02
 5.0000000000E+01
Tilts:
 0.0000000000E+00
 1.8430000000E+01
 2.6570000000E+01
 3.3210000000E+01
 3.9230000000E+01
 4.5000000000E+01
PSD Degrees/Channel =  3.92000000E-02
PSD Two Theta Not   = 156.000
PSD Channel Not     =  2.7E+02
PSD First Channel   =   79
PSD Last Channel    =  600
PSD Cycling Time    =  15.00
Tolerance =  5.0000000000E+00  MPa

Applied Stress =  203.9794  MPa
Psi =   0.000
Background Intensity =      0.00
```

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
154.785	42.73	0.755	22.488	75.000
154.824	42.49	0.753	22.358	75.000
154.863	44.55	0.771	23.440	75.000
154.902	42.35	0.751	22.274	75.000
154.942	42.27	0.751	22.229	75.000
154.981	43.47	0.761	22.860	75.000
155.020	43.61	0.763	22.934	75.000
155.059	43.27	0.760	22.748	75.000
155.098	44.19	0.768	23.231	75.000
155.138	47.64	0.797	25.053	75.000
155.177	47.17	0.793	24.803	75.000
155.216	47.51	0.796	24.976	75.000
155.255	50.25	0.819	26.424	75.000
155.294	50.96	0.824	26.794	75.000
155.334	49.92	0.816	26.241	75.000
155.373	50.17	0.818	26.371	75.000
155.412	51.67	0.830	27.157	75.000
155.451	52.76	0.839	27.732	75.000
155.490	54.21	0.850	28.496	75.000
155.530	54.96	0.856	28.887	75.000
155.569	54.52	0.853	28.651	75.000
155.608	54.24	0.850	28.499	75.000
155.647	57.49	0.876	30.215	75.000
155.686	56.17	0.865	29.513	75.000
155.726	56.55	0.868	29.707	75.000
155.765	57.29	0.874	30.098	75.000
155.804	56.29	0.866	29.565	75.000
155.843	56.71	0.870	29.780	75.000
155.882	57.17	0.873	30.022	75.000
155.922	54.61	0.853	28.666	75.000
155.961	56.87	0.871	29.852	75.000
156.000	55.81	0.863	29.292	75.000
156.039	56.33	0.867	29.563	75.000
156.078	56.56	0.868	29.679	75.000
156.118	56.16	0.865	29.463	75.000
156.157	54.25	0.851	28.453	75.000
156.196	51.69	0.830	27.099	75.000
156.235	53.07	0.841	27.820	75.000
156.274	52.07	0.833	27.289	75.000
156.314	51.29	0.827	26.878	75.000
156.353	51.77	0.831	27.127	75.000
156.392	50.01	0.817	26.197	75.000
156.431	49.63	0.813	25.989	75.000
156.470	50.19	0.818	26.281	75.000
156.510	49.40	0.812	25.863	75.000
156.549	48.96	0.808	25.628	75.000
156.588	47.60	0.797	24.909	75.000
156.627	49.32	0.811	25.811	75.000
156.666	46.88	0.791	24.524	75.000
156.706	47.23	0.794	24.704	75.000
156.745	46.40	0.787	24.266	75.000
156.784	48.17	0.801	25.195	75.000
156.823	46.49	0.787	24.309	75.000
156.862	46.16	0.785	24.130	75.000
156.902	46.79	0.790	24.456	75.000
156.941	45.32	0.777	23.683	75.000
156.980	47.15	0.793	24.639	75.000
157.019	45.21	0.776	23.621	75.000
157.058	43.56	0.762	22.750	75.000
157.098	45.15	0.776	23.580	75.000
157.137	43.67	0.763	22.800	75.000
157.176	44.20	0.768	23.077	75.000
157.215	42.77	0.755	22.326	75.000
157.254	42.35	0.751	22.099	75.000
157.333	41.89	0.747	21.856	75.000
157.450	41.49	0.744	21.638	75.000 Peak = 155.99538

STD(Peak) = 0.00782

Applied Stress = 203.5215 MPa

Psi = 18.430
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.020	45.49	0.711	25.859	90.000
155.059	46.92	0.722	26.672	90.000
155.098	46.68	0.720	26.525	90.000
155.138	49.16	0.739	27.935	90.000
155.177	50.53	0.749	28.716	90.000
155.216	50.23	0.747	28.537	90.000
155.255	51.92	0.760	29.495	90.000
155.294	53.79	0.773	30.555	90.000
155.334	52.13	0.761	29.600	90.000
155.373	54.10	0.775	30.717	90.000
155.412	56.53	0.793	32.101	90.000
155.451	57.04	0.796	32.385	90.000
155.490	58.59	0.807	33.260	90.000
155.530	57.89	0.802	32.851	90.000
155.569	57.51	0.799	32.626	90.000
155.608	58.79	0.808	33.348	90.000
155.647	58.64	0.807	33.257	90.000
155.686	60.66	0.821	34.398	90.000
155.726	58.92	0.809	33.398	90.000
155.765	60.34	0.819	34.202	90.000
155.804	61.08	0.824	34.612	90.000
155.843	59.94	0.816	33.956	90.000
155.882	60.52	0.820	34.277	90.000
155.922	58.81	0.808	33.291	90.000
155.961	58.99	0.810	33.384	90.000
156.000	58.09	0.803	32.862	90.000
156.039	57.82	0.802	32.701	90.000
156.078	57.38	0.798	32.440	90.000
156.118	57.59	0.800	32.552	90.000
156.157	55.27	0.784	31.221	90.000
156.196	57.07	0.796	32.237	90.000
156.235	56.72	0.794	32.033	90.000
156.274	53.53	0.771	30.211	90.000
156.314	51.80	0.759	29.219	90.000
156.353	54.07	0.775	30.499	90.000
156.392	52.71	0.765	29.721	90.000
156.431	52.33	0.763	29.499	90.000
156.470	50.36	0.748	28.369	90.000
156.510	50.60	0.750	28.500	90.000
156.549	49.20	0.739	27.699	90.000
156.588	50.09	0.746	28.196	90.000
156.627	49.33	0.740	27.761	90.000
156.666	49.53	0.742	27.867	90.000
156.706	48.36	0.733	27.193	90.000
156.745	48.39	0.733	27.205	90.000
156.784	47.79	0.729	26.858	90.000
156.823	46.32	0.717	26.022	90.000
156.862	48.32	0.733	27.146	90.000
156.902	46.78	0.721	26.266	90.000
156.941	47.32	0.725	26.567	90.000
156.980	45.89	0.714	25.751	90.000
157.019	45.32	0.710	25.425	90.000
157.098	46.27	0.717	25.945	90.000

Peak = 155.90230
STD(Peak) = 0.00784

Applied Stress = 203.2926 MPa
Psi = 26.570
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.020	47.55	0.890	28.102	60.000
155.059	47.83	0.893	28.260	60.000
155.098	48.18	0.896	28.458	60.000
155.138	50.73	0.920	29.961	60.000
155.177	51.90	0.930	30.643	60.000
155.216	54.00	0.949	31.878	60.000
155.255	53.93	0.948	31.828	60.000
155.294	57.47	0.979	33.913	60.000

155.334	58.12	0.984	34.287	60.000
155.373	56.52	0.971	33.327	60.000
155.412	59.38	0.995	35.015	60.000
155.451	58.98	0.991	34.766	60.000
155.490	61.53	1.013	36.265	60.000
155.530	61.35	1.011	36.144	60.000
155.569	60.12	1.001	35.402	60.000
155.608	61.88	1.016	36.436	60.000
155.647	62.48	1.020	36.779	60.000
155.686	63.28	1.027	37.240	60.000
155.726	62.40	1.020	36.705	60.000
155.765	62.62	1.022	36.821	60.000
155.804	61.83	1.015	36.346	60.000
155.843	61.65	1.014	36.225	60.000
155.882	60.62	1.005	35.603	60.000
155.922	61.13	1.009	35.896	60.000
155.961	59.68	0.997	35.028	60.000
156.000	58.00	0.983	34.024	60.000
156.039	60.37	1.003	35.408	60.000
156.078	57.75	0.981	33.854	60.000
156.118	57.32	0.977	33.588	60.000
156.157	57.23	0.977	33.527	60.000
156.196	55.65	0.963	32.585	60.000
156.235	54.07	0.949	31.642	60.000
156.274	57.88	0.982	33.877	60.000
156.314	55.98	0.966	32.748	60.000
156.353	53.77	0.947	31.435	60.000
156.392	54.00	0.949	31.562	60.000
156.431	53.18	0.941	31.072	60.000
156.470	52.25	0.933	30.514	60.000
156.510	52.95	0.939	30.914	60.000
156.549	49.50	0.908	28.882	60.000
156.588	51.87	0.930	30.259	60.000
156.627	49.03	0.904	28.589	60.000
156.666	47.20	0.887	27.507	60.000
156.706	49.58	0.909	28.893	60.000
156.745	48.08	0.895	28.006	60.000
156.784	49.22	0.906	28.659	60.000
156.862	47.28	0.888	27.511	60.000 Peak = 155.83102

STD(Peak) = 0.00798

Applied Stress = 203.2926 MPa
Psi = 33.210
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
154.981	49.88	0.912	30.680	60.000
155.020	50.58	0.918	31.100	60.000
155.059	52.18	0.933	32.075	60.000
155.098	50.95	0.922	31.300	60.000
155.138	53.35	0.943	32.769	60.000
155.177	54.55	0.954	33.496	60.000
155.216	56.40	0.970	34.623	60.000
155.255	57.88	0.982	35.524	60.000
155.294	58.63	0.989	35.972	60.000
155.334	60.87	1.007	37.334	60.000
155.373	58.68	0.989	35.973	60.000
155.412	62.12	1.017	38.074	60.000
155.451	64.03	1.033	39.240	60.000
155.490	64.60	1.038	39.573	60.000
155.530	61.93	1.016	37.915	60.000
155.569	62.33	1.019	38.146	60.000
155.608	64.03	1.033	39.176	60.000
155.647	64.03	1.033	39.160	60.000
155.686	64.50	1.037	39.431	60.000
155.726	63.42	1.028	38.749	60.000
155.765	64.38	1.036	39.328	60.000
155.804	62.23	1.018	37.992	60.000
155.843	61.85	1.015	37.741	60.000
155.882	62.28	1.019	37.991	60.000
155.922	59.83	0.999	36.474	60.000

155.961	61.58	1.013	37.532	60.000
156.000	61.32	1.011	37.353	60.000
156.039	58.37	0.986	35.532	60.000
156.078	58.77	0.990	35.763	60.000
156.118	58.65	0.989	35.677	60.000
156.157	58.20	0.985	35.387	60.000
156.196	56.45	0.970	34.304	60.000
156.235	55.20	0.959	33.527	60.000
156.274	56.57	0.971	34.348	60.000
156.314	53.62	0.945	32.535	60.000
156.353	54.63	0.954	33.141	60.000
156.392	54.72	0.955	33.179	60.000
156.431	54.20	0.950	32.851	60.000
156.470	52.50	0.935	31.803	60.000
156.510	50.92	0.921	30.827	60.000
156.549	51.58	0.927	31.220	60.000
156.588	50.45	0.917	30.519	60.000
156.627	49.87	0.912	30.152	60.000
156.666	48.52	0.899	29.321	60.000 Peak = 155.74926

STD(Peak) = 0.00755

Applied Stress = 203.0637 MPa
Psi = 39.230
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
154.981	52.07	0.833	33.473	75.000
155.020	51.75	0.831	33.250	75.000
155.059	53.40	0.844	34.301	75.000
155.098	53.83	0.847	34.560	75.000
155.138	54.92	0.856	35.249	75.000
155.177	58.73	0.885	37.694	75.000
155.216	60.28	0.897	38.675	75.000
155.255	61.77	0.908	39.620	75.000
155.294	63.11	0.917	40.461	75.000
155.334	62.71	0.914	40.183	75.000
155.373	62.67	0.914	40.138	75.000
155.412	65.61	0.935	42.019	75.000
155.451	65.99	0.938	42.239	75.000
155.490	66.79	0.944	42.734	75.000
155.530	64.60	0.928	41.304	75.000
155.569	65.89	0.937	42.117	75.000
155.608	64.19	0.925	40.998	75.000
155.647	66.01	0.938	42.153	75.000
155.686	64.99	0.931	41.472	75.000
155.726	64.17	0.925	40.929	75.000
155.765	66.89	0.944	42.656	75.000
155.804	64.71	0.929	41.232	75.000
155.843	62.05	0.910	39.510	75.000
155.882	62.15	0.910	39.551	75.000
155.922	61.36	0.905	39.027	75.000
155.961	59.36	0.890	37.728	75.000
156.000	59.92	0.894	38.068	75.000
156.039	59.67	0.892	37.888	75.000
156.078	59.16	0.888	37.546	75.000
156.118	58.12	0.880	36.864	75.000
156.157	56.00	0.864	35.493	75.000
156.196	57.49	0.876	36.428	75.000
156.235	57.35	0.874	36.317	75.000
156.274	55.68	0.862	35.238	75.000
156.314	55.12	0.857	34.865	75.000
156.353	54.81	0.855	34.653	75.000
156.392	52.53	0.837	33.187	75.000
156.431	54.31	0.851	34.297	75.000
156.470	53.79	0.847	33.951	75.000
156.510	52.96	0.840	33.410	75.000
156.549	51.31	0.827	32.345	75.000
156.588	51.08	0.825	32.186	75.000 Peak = 155.68699

STD(Peak) = 0.00733

Applied Stress = 203.0637 MPa
Psi = 45.000
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
154.981	52.31	0.762	35.433	90.000
155.020	55.36	0.784	37.488	90.000
155.059	56.07	0.789	37.951	90.000
155.098	56.32	0.791	38.102	90.000
155.138	60.68	0.821	41.049	90.000
155.177	60.84	0.822	41.138	90.000
155.216	61.97	0.830	41.878	90.000
155.255	63.16	0.838	42.663	90.000
155.294	63.89	0.843	43.137	90.000
155.334	65.32	0.852	44.088	90.000
155.373	64.67	0.848	43.615	90.000
155.412	67.34	0.865	45.411	90.000
155.451	68.28	0.871	46.019	90.000
155.490	67.61	0.867	45.539	90.000
155.530	65.68	0.854	44.199	90.000
155.569	66.49	0.860	44.723	90.000
155.608	66.10	0.857	44.433	90.000
155.647	66.89	0.862	44.941	90.000
155.686	65.31	0.852	43.846	90.000
155.726	65.92	0.856	44.234	90.000
155.765	64.98	0.850	43.569	90.000
155.804	63.39	0.839	42.469	90.000
155.843	64.02	0.843	42.872	90.000
155.882	62.13	0.831	41.572	90.000
155.922	60.42	0.819	40.394	90.000
155.961	61.77	0.828	41.276	90.000
156.000	60.83	0.822	40.624	90.000
156.039	60.52	0.820	40.391	90.000
156.078	58.94	0.809	39.306	90.000
156.118	57.87	0.802	38.559	90.000
156.157	58.72	0.808	39.111	90.000
156.196	57.06	0.796	37.970	90.000
156.235	57.67	0.800	38.358	90.000
156.274	55.58	0.786	36.936	90.000
156.314	56.03	0.789	37.220	90.000
156.353	55.13	0.783	36.596	90.000
156.392	53.57	0.771	35.528	90.000
156.431	52.61	0.765	34.869	90.000
156.470	51.93	0.760	34.397	90.000
156.510	52.24	0.762	34.584	90.000
156.549	52.84	0.766	34.964	90.000 Peak = 155.62985

STD(Peak) = 0.00753

Applied Stress = 148.3486 MPa
Psi = 0.000
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
154.863	43.04	0.758	22.644	75.000
154.942	43.73	0.764	23.004	75.000
154.981	43.24	0.759	22.740	75.000
155.020	44.96	0.774	23.646	75.000
155.059	44.88	0.774	23.600	75.000
155.098	43.64	0.763	22.942	75.000
155.138	47.68	0.797	25.074	75.000
155.177	47.09	0.792	24.761	75.000
155.216	48.87	0.807	25.695	75.000
155.255	48.76	0.806	25.635	75.000
155.294	49.93	0.816	26.252	75.000
155.334	50.89	0.824	26.756	75.000
155.373	51.61	0.830	27.133	75.000
155.412	52.99	0.841	27.855	75.000
155.451	53.28	0.843	28.007	75.000
155.490	55.99	0.864	29.434	75.000
155.530	54.43	0.852	28.605	75.000
155.569	54.91	0.856	28.855	75.000
155.608	56.64	0.869	29.768	75.000

155.647	57.37	0.875	30.152	75.000
155.686	57.71	0.877	30.324	75.000
155.726	58.37	0.882	30.673	75.000
155.765	56.15	0.865	29.491	75.000
155.804	57.52	0.876	30.213	75.000
155.843	58.40	0.882	30.675	75.000
155.882	57.61	0.876	30.255	75.000
155.922	56.52	0.868	29.673	75.000
155.961	56.44	0.867	29.627	75.000
156.000	56.72	0.870	29.771	75.000
156.039	54.93	0.856	28.823	75.000
156.078	54.32	0.851	28.496	75.000
156.118	54.35	0.851	28.506	75.000
156.157	54.71	0.854	28.693	75.000
156.196	52.12	0.834	27.324	75.000
156.235	52.73	0.839	27.644	75.000
156.274	52.52	0.837	27.528	75.000
156.314	51.20	0.826	26.829	75.000
156.353	50.09	0.817	26.242	75.000
156.392	51.44	0.828	26.948	75.000
156.431	48.92	0.808	25.617	75.000
156.470	49.45	0.812	25.895	75.000
156.510	49.20	0.810	25.758	75.000
156.549	48.57	0.805	25.425	75.000
156.588	48.56	0.805	25.415	75.000
156.627	48.57	0.805	25.418	75.000
156.666	47.83	0.799	25.022	75.000
156.706	47.45	0.795	24.823	75.000
156.745	47.05	0.792	24.609	75.000
156.784	45.61	0.780	23.849	75.000
156.823	47.19	0.793	24.673	75.000
156.862	45.20	0.776	23.626	75.000
156.902	45.59	0.780	23.826	75.000
156.941	45.47	0.779	23.760	75.000
156.980	44.17	0.767	23.078	75.000
157.019	44.59	0.771	23.292	75.000
157.058	43.96	0.766	22.960	75.000
157.098	43.51	0.762	22.719	75.000
157.137	44.05	0.766	23.003	75.000
157.176	43.05	0.758	22.475	75.000 Peak = 155.94721

STD(Peak) = 0.00777

Applied Stress = 148.1197 MPa
Psi = 18.430
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
154.942	44.40	0.769	25.224	75.000
154.981	44.43	0.770	25.233	75.000
155.020	45.79	0.781	26.002	75.000
155.059	46.76	0.790	26.551	75.000
155.098	47.87	0.799	27.176	75.000
155.138	47.69	0.797	27.070	75.000
155.177	48.83	0.807	27.709	75.000
155.216	50.92	0.824	28.896	75.000
155.255	52.40	0.836	29.733	75.000
155.294	52.77	0.839	29.938	75.000
155.334	53.99	0.848	30.623	75.000
155.373	53.39	0.844	30.272	75.000
155.412	57.68	0.877	32.714	75.000
155.451	58.56	0.884	33.208	75.000
155.490	58.25	0.881	33.024	75.000
155.530	56.69	0.869	32.126	75.000
155.569	59.81	0.893	33.897	75.000
155.608	57.97	0.879	32.839	75.000
155.647	58.68	0.885	33.233	75.000
155.686	59.81	0.893	33.870	75.000
155.726	59.23	0.889	33.527	75.000
155.765	60.35	0.897	34.156	75.000
155.804	58.73	0.885	33.228	75.000
155.843	59.95	0.894	33.911	75.000

155.882	60.21	0.896	34.054	75.000
155.922	58.45	0.883	33.043	75.000
155.961	58.53	0.883	33.080	75.000
156.000	58.05	0.880	32.799	75.000
156.039	58.73	0.885	33.177	75.000
156.078	56.95	0.871	32.153	75.000
156.118	56.05	0.865	31.637	75.000
156.157	55.37	0.859	31.242	75.000
156.196	55.96	0.864	31.567	75.000
156.235	55.11	0.857	31.075	75.000
156.274	53.60	0.845	30.212	75.000
156.314	54.32	0.851	30.613	75.000
156.353	52.53	0.837	29.592	75.000
156.392	52.57	0.837	29.607	75.000
156.431	52.43	0.836	29.517	75.000
156.470	51.92	0.832	29.222	75.000
156.510	52.39	0.836	29.479	75.000
156.549	49.80	0.815	28.008	75.000
156.588	50.19	0.818	28.219	75.000
156.627	49.20	0.810	27.654	75.000
156.666	49.19	0.810	27.640	75.000
156.706	48.37	0.803	27.173	75.000
156.745	46.97	0.791	26.376	75.000
156.784	48.17	0.801	27.046	75.000
156.823	47.21	0.793	26.498	75.000
156.862	47.45	0.795	26.626	75.000
156.902	46.09	0.784	25.853	75.000
156.941	46.89	0.791	26.297	75.000
156.980	45.53	0.779	25.524	75.000
157.019	45.88	0.782	25.713	75.000
157.058	44.83	0.773	25.113	75.000 Peak = 155.91217

STD(Peak) = 0.00708

Applied Stress = 148.1197 MPa
Psi = 26.570
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.020	46.99	0.792	27.797	75.000
155.059	48.27	0.802	28.549	75.000
155.098	48.81	0.807	28.864	75.000
155.138	51.87	0.832	30.670	75.000
155.177	53.08	0.841	31.381	75.000
155.216	51.76	0.831	30.586	75.000
155.255	54.43	0.852	32.160	75.000
155.294	55.57	0.861	32.831	75.000
155.334	57.21	0.873	33.795	75.000
155.373	56.75	0.870	33.506	75.000
155.412	59.44	0.890	35.095	75.000
155.451	61.04	0.902	36.035	75.000
155.490	61.03	0.902	36.015	75.000
155.530	60.97	0.902	35.971	75.000
155.569	60.55	0.898	35.705	75.000
155.608	62.47	0.913	36.833	75.000
155.647	61.28	0.904	36.117	75.000
155.686	61.68	0.907	36.342	75.000
155.726	62.28	0.911	36.686	75.000
155.765	62.93	0.916	37.061	75.000
155.804	63.33	0.919	37.286	75.000
155.843	60.49	0.898	35.591	75.000
155.882	61.99	0.909	36.463	75.000
155.961	60.45	0.898	35.531	75.000
156.000	59.95	0.894	35.220	75.000
156.039	58.64	0.884	34.436	75.000
156.078	57.73	0.877	33.889	75.000
156.118	56.11	0.865	32.917	75.000
156.157	56.69	0.869	33.252	75.000
156.196	55.63	0.861	32.612	75.000
156.235	55.88	0.863	32.750	75.000
156.274	55.27	0.858	32.378	75.000
156.314	55.28	0.859	32.375	75.000

156.353	54.28	0.851	31.775	75.000
156.392	54.13	0.850	31.679	75.000
156.431	52.35	0.835	30.617	75.000
156.470	52.25	0.835	30.552	75.000
156.510	50.53	0.821	29.531	75.000
156.549	51.51	0.829	30.093	75.000
156.588	50.32	0.819	29.386	75.000
156.627	51.23	0.826	29.909	75.000
156.666	49.63	0.813	28.960	75.000
156.706	49.05	0.809	28.614	75.000
156.745	49.57	0.813	28.910	75.000
156.784	48.07	0.801	28.017	75.000
156.823	47.17	0.793	27.485	75.000
156.862	47.61	0.797	27.733	75.000
156.902	46.97	0.791	27.350	75.000 Peak = 155.83714

STD(Peak) = 0.00775

Applied Stress = 148.1197 MPa
Psi = 33.210
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.059	49.77	0.688	30.689	105.000
155.098	49.22	0.685	30.334	105.000
155.138	55.01	0.724	33.920	105.000
155.177	54.29	0.719	33.456	105.000
155.216	55.70	0.728	34.318	105.000
155.255	58.31	0.745	35.932	105.000
155.294	58.69	0.748	36.148	105.000
155.334	59.02	0.750	36.341	105.000
155.373	60.44	0.759	37.208	105.000
155.412	61.69	0.766	37.968	105.000
155.451	64.39	0.783	39.633	105.000
155.490	64.62	0.784	39.759	105.000
155.530	63.22	0.776	38.873	105.000
155.569	63.72	0.779	39.171	105.000
155.608	63.20	0.776	38.830	105.000
155.647	63.90	0.780	39.251	105.000
155.686	63.67	0.779	39.088	105.000
155.726	65.64	0.791	40.294	105.000
155.765	64.24	0.782	39.410	105.000
155.804	61.81	0.767	37.890	105.000
155.843	63.20	0.776	38.736	105.000
155.882	61.63	0.766	37.748	105.000
155.922	60.66	0.760	37.132	105.000
155.961	60.45	0.759	36.988	105.000
156.000	59.75	0.754	36.543	105.000
156.039	59.31	0.752	36.258	105.000
156.078	59.28	0.751	36.220	105.000
156.118	58.17	0.744	35.524	105.000
156.157	57.97	0.743	35.387	105.000
156.196	57.24	0.738	34.921	105.000
156.235	56.79	0.735	34.632	105.000
156.274	54.90	0.723	33.452	105.000
156.314	56.55	0.734	34.458	105.000
156.353	53.96	0.717	32.852	105.000
156.392	54.45	0.720	33.137	105.000
156.431	53.57	0.714	32.587	105.000
156.470	52.71	0.709	32.048	105.000
156.510	52.24	0.705	31.743	105.000
156.549	53.41	0.713	32.448	105.000
156.588	51.32	0.699	31.158	105.000
156.627	50.89	0.696	30.878	105.000
156.706	50.81	0.696	30.807	105.000 Peak = 155.76552

STD(Peak) = 0.00678

Applied Stress = 148.1197 MPa
Psi = 39.230
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time

155.020	51.48	0.828	33.077	75.000
155.059	51.37	0.828	32.992	75.000
155.098	51.63	0.830	33.139	75.000
155.138	55.53	0.860	35.645	75.000
155.177	56.47	0.868	36.230	75.000
155.216	58.39	0.882	37.452	75.000
155.255	60.08	0.895	38.526	75.000
155.294	61.25	0.904	39.265	75.000
155.334	61.92	0.909	39.676	75.000
155.373	62.61	0.914	40.103	75.000
155.412	64.65	0.928	41.399	75.000
155.451	65.28	0.933	41.783	75.000
155.490	66.41	0.941	42.493	75.000
155.530	63.59	0.921	40.652	75.000
155.569	63.65	0.921	40.675	75.000
155.608	62.76	0.915	40.080	75.000
155.647	65.96	0.938	42.118	75.000
155.686	65.40	0.934	41.738	75.000
155.726	64.65	0.928	41.238	75.000
155.765	65.13	0.932	41.526	75.000
155.804	62.52	0.913	39.829	75.000
155.843	63.89	0.923	40.690	75.000
155.882	62.63	0.914	39.858	75.000
155.922	61.92	0.909	39.386	75.000
155.961	62.49	0.913	39.734	75.000
156.000	61.43	0.905	39.032	75.000
156.039	59.17	0.888	37.573	75.000
156.078	59.21	0.889	37.580	75.000
156.118	58.49	0.883	37.102	75.000
156.157	57.51	0.876	36.454	75.000
156.196	56.47	0.868	35.774	75.000
156.235	58.39	0.882	36.980	75.000
156.274	55.73	0.862	35.272	75.000
156.314	55.87	0.863	35.340	75.000
156.353	55.85	0.863	35.314	75.000
156.392	54.51	0.852	34.441	75.000
156.431	54.04	0.849	34.128	75.000
156.470	53.20	0.842	33.578	75.000
156.510	51.08	0.825	32.217	75.000
156.549	52.65	0.838	33.199	75.000
156.627	51.47	0.828	32.415	75.000 Peak = 155.72335

STD(Peak) = 0.00731

Applied Stress = 148.1197 MPa
Psi = 45.000
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
154.981	52.55	0.936	35.511	60.000
155.020	54.08	0.949	36.531	60.000
155.059	53.72	0.946	36.260	60.000
155.098	54.65	0.954	36.871	60.000
155.138	56.40	0.970	38.036	60.000
155.177	60.53	1.004	40.814	60.000
155.216	61.43	1.012	41.399	60.000
155.255	63.18	1.026	42.560	60.000
155.294	63.83	1.031	42.975	60.000
155.334	62.67	1.022	42.160	60.000
155.373	61.90	1.016	41.617	60.000
155.412	67.43	1.060	45.333	60.000
155.451	67.17	1.058	45.126	60.000
155.490	66.88	1.056	44.908	60.000
155.530	67.88	1.064	45.556	60.000
155.569	65.83	1.047	44.146	60.000
155.608	64.93	1.040	43.513	60.000
155.647	67.42	1.060	45.161	60.000
155.686	65.38	1.044	43.765	60.000
155.726	67.35	1.059	45.063	60.000
155.765	64.08	1.033	42.839	60.000
155.804	63.02	1.025	42.097	60.000
155.843	64.42	1.036	43.013	60.000

155.882	61.75	1.014	41.198	60.000
155.922	61.62	1.013	41.085	60.000
155.961	62.40	1.020	41.585	60.000
156.000	63.22	1.026	42.108	60.000
156.039	59.62	0.997	39.674	60.000
156.078	57.92	0.982	38.514	60.000
156.118	57.87	0.982	38.458	60.000
156.157	58.70	0.989	38.992	60.000
156.196	57.73	0.981	38.324	60.000
156.235	56.95	0.974	37.780	60.000
156.274	57.03	0.975	37.813	60.000
156.314	55.23	0.959	36.593	60.000
156.353	57.17	0.976	37.858	60.000
156.392	53.37	0.943	35.309	60.000
156.431	52.73	0.937	34.868	60.000
156.470	52.10	0.932	34.427	60.000
156.510	53.18	0.941	35.126	60.000 Peak = 155.66341

STD(Peak) = 0.00775

Applied Stress = 103.2488 MPa
Psi = 0.000
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
154.746	43.05	0.758	22.660	75.000
154.863	43.23	0.759	22.742	75.000
154.902	43.85	0.765	23.071	75.000
154.942	43.36	0.760	22.807	75.000
154.981	44.27	0.768	23.283	75.000
155.020	45.29	0.777	23.822	75.000
155.059	47.03	0.792	24.735	75.000
155.098	45.15	0.776	23.738	75.000
155.138	47.05	0.792	24.743	75.000
155.177	50.20	0.818	26.403	75.000
155.216	49.55	0.813	26.054	75.000
155.255	49.83	0.815	26.199	75.000
155.294	52.79	0.839	27.761	75.000
155.334	51.45	0.828	27.052	75.000
155.373	51.37	0.828	27.006	75.000
155.412	55.41	0.860	29.139	75.000
155.451	53.00	0.841	27.858	75.000
155.490	55.84	0.863	29.357	75.000
155.530	56.49	0.868	29.698	75.000
155.569	56.23	0.866	29.553	75.000
155.608	55.51	0.860	29.169	75.000
155.647	57.00	0.872	29.955	75.000
155.686	56.68	0.869	29.781	75.000
155.726	57.35	0.874	30.130	75.000
155.765	57.99	0.879	30.464	75.000
155.804	56.57	0.869	29.713	75.000
155.843	56.81	0.870	29.836	75.000
155.882	56.71	0.870	29.776	75.000
155.922	55.23	0.858	28.990	75.000
155.961	57.67	0.877	30.275	75.000
156.000	56.37	0.867	29.588	75.000
156.039	55.47	0.860	29.105	75.000
156.078	54.77	0.855	28.735	75.000
156.118	54.88	0.855	28.788	75.000
156.157	52.93	0.840	27.757	75.000
156.196	52.99	0.841	27.781	75.000
156.235	52.29	0.835	27.412	75.000
156.274	53.43	0.844	28.006	75.000
156.314	51.40	0.828	26.934	75.000
156.353	50.53	0.821	26.474	75.000
156.392	50.28	0.819	26.337	75.000
156.431	50.52	0.821	26.460	75.000
156.470	50.40	0.820	26.393	75.000
156.510	50.05	0.817	26.207	75.000
156.549	50.03	0.817	26.190	75.000
156.588	49.11	0.809	25.702	75.000
156.627	46.64	0.789	24.401	75.000

156.666	46.59	0.788	24.370	75.000
156.706	47.32	0.794	24.753	75.000
156.745	46.17	0.785	24.147	75.000
156.784	47.67	0.797	24.929	75.000
156.823	45.95	0.783	24.021	75.000
156.862	46.27	0.785	24.186	75.000
156.902	46.23	0.785	24.162	75.000
156.941	44.27	0.768	23.130	75.000
156.980	43.88	0.765	22.924	75.000
157.019	44.97	0.774	23.495	75.000
157.058	43.96	0.766	22.960	75.000
157.098	44.64	0.771	23.314	75.000
157.137	43.00	0.757	22.450	75.000 Peak = 155.91242

STD(Peak) = 0.00753

Applied Stress = 103.2488 MPa
Psi = 18.430
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
154.981	46.04	0.783	26.154	75.000
155.020	46.28	0.786	26.284	75.000
155.059	46.80	0.790	26.574	75.000
155.098	48.83	0.807	27.724	75.000
155.138	48.15	0.801	27.328	75.000
155.177	51.17	0.826	29.048	75.000
155.216	51.41	0.828	29.178	75.000
155.255	53.77	0.847	30.517	75.000
155.294	53.40	0.844	30.296	75.000
155.334	54.28	0.851	30.790	75.000
155.373	54.17	0.850	30.721	75.000
155.412	56.29	0.866	31.923	75.000
155.451	59.68	0.892	33.847	75.000
155.490	58.85	0.886	33.367	75.000
155.530	59.08	0.888	33.487	75.000
155.569	56.88	0.871	32.224	75.000
155.608	59.32	0.889	33.607	75.000
155.647	58.76	0.885	33.278	75.000
155.686	60.81	0.900	34.440	75.000
155.726	61.25	0.904	34.682	75.000
155.765	60.27	0.896	34.111	75.000
155.804	59.95	0.894	33.920	75.000
155.843	60.65	0.899	34.313	75.000
155.882	59.07	0.887	33.401	75.000
155.922	59.92	0.894	33.878	75.000
155.961	58.25	0.881	32.921	75.000
156.000	58.17	0.881	32.867	75.000
156.039	58.53	0.883	33.063	75.000
156.078	58.27	0.881	32.903	75.000
156.118	56.29	0.866	31.773	75.000
156.157	56.27	0.866	31.750	75.000
156.196	54.57	0.853	30.780	75.000
156.235	54.64	0.854	30.810	75.000
156.274	54.59	0.853	30.772	75.000
156.314	53.77	0.847	30.303	75.000
156.353	53.91	0.848	30.371	75.000
156.392	52.13	0.834	29.358	75.000
156.431	52.60	0.837	29.615	75.000
156.470	51.65	0.830	29.071	75.000
156.510	50.69	0.822	28.520	75.000
156.549	51.23	0.826	28.815	75.000
156.588	49.20	0.810	27.661	75.000
156.627	49.47	0.812	27.805	75.000
156.666	48.89	0.807	27.474	75.000
156.706	47.39	0.795	26.616	75.000
156.745	48.57	0.805	27.279	75.000
156.784	47.96	0.800	26.926	75.000
156.823	48.69	0.806	27.333	75.000
156.862	46.80	0.790	26.258	75.000
156.902	45.01	0.775	25.244	75.000
156.941	46.13	0.784	25.869	75.000

156.980	46.56	0.788	26.102	75.000	
157.019	46.32	0.786	25.961	75.000 Peak	= 155.88247

STD(Peak) = 0.00781

Applied Stress = 103.0199 MPa
Psi = 26.570
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.020	47.63	0.728	28.212	90.000
155.059	48.71	0.736	28.845	90.000
155.098	49.19	0.739	29.120	90.000
155.138	50.07	0.746	29.633	90.000
155.177	51.53	0.757	30.497	90.000
155.216	53.29	0.769	31.533	90.000
155.255	54.79	0.780	32.416	90.000
155.294	56.89	0.795	33.657	90.000
155.334	56.90	0.795	33.652	90.000
155.373	55.40	0.785	32.747	90.000
155.412	59.49	0.813	35.172	90.000
155.451	60.38	0.819	35.690	90.000
155.490	61.14	0.824	36.135	90.000
155.530	59.68	0.814	35.249	90.000
155.569	58.83	0.809	34.735	90.000
155.608	60.83	0.822	35.913	90.000
155.647	62.87	0.836	37.111	90.000
155.686	61.78	0.829	36.451	90.000
155.726	62.89	0.836	37.100	90.000
155.765	62.72	0.835	36.988	90.000
155.804	61.07	0.824	35.992	90.000
155.843	61.28	0.825	36.105	90.000
155.882	60.92	0.823	35.882	90.000
155.922	61.68	0.828	36.319	90.000
155.961	59.57	0.814	35.054	90.000
156.000	59.16	0.811	34.799	90.000
156.039	58.23	0.804	34.240	90.000
156.078	56.28	0.791	33.071	90.000
156.118	57.00	0.796	33.487	90.000
156.157	56.88	0.795	33.404	90.000
156.196	55.72	0.787	32.709	90.000
156.235	55.58	0.786	32.613	90.000
156.274	54.66	0.779	32.057	90.000
156.314	53.02	0.768	31.082	90.000
156.353	54.17	0.776	31.748	90.000
156.392	54.03	0.775	31.658	90.000
156.431	52.40	0.763	30.685	90.000
156.470	52.56	0.764	30.766	90.000
156.510	50.21	0.747	29.375	90.000
156.549	51.42	0.756	30.078	90.000
156.588	50.79	0.751	29.696	90.000
156.627	49.32	0.740	28.823	90.000
156.666	49.04	0.738	28.650	90.000
156.706	48.99	0.738	28.608	90.000
156.745	49.20	0.739	28.723	90.000
156.784	46.89	0.722	27.356	90.000
156.823	48.80	0.736	28.469	90.000 Peak = 155.82317

STD(Peak) = 0.00685

Applied Stress = 103.2488 MPa
Psi = 33.210
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.020	50.99	0.825	31.385	75.000
155.059	50.96	0.824	31.356	75.000
155.098	50.37	0.820	30.980	75.000
155.138	53.84	0.847	33.111	75.000
155.177	54.60	0.853	33.568	75.000
155.216	56.64	0.869	34.816	75.000
155.255	57.03	0.872	35.041	75.000
155.294	58.32	0.882	35.826	75.000

155.334	58.52	0.883	35.935	75.000
155.373	58.83	0.886	36.110	75.000
155.412	62.92	0.916	38.625	75.000
155.451	62.19	0.911	38.156	75.000
155.490	65.51	0.935	40.191	75.000
155.530	63.15	0.918	38.717	75.000
155.569	62.89	0.916	38.545	75.000
155.608	62.75	0.915	38.439	75.000
155.647	65.43	0.934	40.077	75.000
155.686	64.13	0.925	39.263	75.000
155.726	63.35	0.919	38.762	75.000
155.765	65.05	0.931	39.798	75.000
155.804	62.85	0.915	38.427	75.000
155.843	61.93	0.909	37.845	75.000
155.882	60.35	0.897	36.854	75.000
155.922	60.28	0.897	36.798	75.000
155.961	59.01	0.887	36.005	75.000
156.000	58.59	0.884	35.729	75.000
156.039	58.51	0.883	35.665	75.000
156.078	57.99	0.879	35.332	75.000
156.118	58.28	0.882	35.497	75.000
156.157	56.44	0.867	34.356	75.000
156.196	57.43	0.875	34.946	75.000
156.235	56.01	0.864	34.067	75.000
156.274	54.77	0.855	33.295	75.000
156.314	54.43	0.852	33.069	75.000
156.353	53.80	0.847	32.673	75.000
156.392	53.88	0.848	32.709	75.000
156.431	54.07	0.849	32.810	75.000
156.470	54.31	0.851	32.943	75.000
156.510	50.71	0.822	30.735	75.000
156.549	53.05	0.841	32.153	75.000
156.588	50.24	0.818	30.426	75.000
156.627	51.27	0.827	31.039	75.000
156.666	50.84	0.823	30.767	75.000 Peak = 155.75182

STD(Peak) = 0.00784

Applied Stress = 103.2488 MPa
Psi = 39.230
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.020	50.56	0.821	32.483	75.000
155.059	52.88	0.840	33.965	75.000
155.098	50.45	0.820	32.382	75.000
155.138	54.32	0.851	34.862	75.000
155.177	57.59	0.876	36.954	75.000
155.216	58.01	0.879	37.211	75.000
155.255	61.39	0.905	39.370	75.000
155.294	60.57	0.899	38.826	75.000
155.334	63.07	0.917	40.416	75.000
155.373	59.97	0.894	38.401	75.000
155.412	63.92	0.923	40.926	75.000
155.451	65.89	0.937	42.179	75.000
155.490	64.65	0.928	41.359	75.000
155.530	64.73	0.929	41.390	75.000
155.569	63.89	0.923	40.829	75.000
155.608	65.64	0.936	41.933	75.000
155.647	64.08	0.924	40.909	75.000
155.686	66.01	0.938	42.132	75.000
155.726	66.29	0.940	42.292	75.000
155.765	64.32	0.926	41.004	75.000
155.804	64.11	0.925	40.847	75.000
155.843	64.40	0.927	41.015	75.000
155.882	61.97	0.909	39.439	75.000
155.922	60.36	0.897	38.387	75.000
155.961	60.45	0.898	38.428	75.000
156.000	62.57	0.913	39.766	75.000
156.039	59.87	0.893	38.016	75.000
156.078	58.75	0.885	37.282	75.000
156.118	58.28	0.882	36.966	75.000

156.157	58.55	0.884	37.118	75.000
156.196	55.72	0.862	35.298	75.000
156.235	56.39	0.867	35.705	75.000
156.274	55.21	0.858	34.941	75.000
156.314	56.41	0.867	35.688	75.000
156.353	55.56	0.861	35.128	75.000
156.392	53.53	0.845	33.822	75.000
156.431	53.85	0.847	34.009	75.000
156.470	55.81	0.863	35.238	75.000
156.510	51.75	0.831	32.640	75.000
156.549	51.77	0.831	32.641	75.000
156.588	52.31	0.835	32.963	75.000
156.627	50.03	0.817	31.503	75.000 Peak = 155.72740

STD(Peak) = 0.00730

Applied Stress = 103.0199 MPa
Psi = 45.000
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.020	51.67	0.830	34.932	75.000
155.059	53.37	0.844	36.071	75.000
155.098	53.76	0.847	36.312	75.000
155.138	56.04	0.864	37.839	75.000
155.177	58.63	0.884	39.574	75.000
155.216	59.72	0.892	40.293	75.000
155.255	60.44	0.898	40.758	75.000
155.294	62.77	0.915	42.317	75.000
155.334	62.19	0.911	41.894	75.000
155.373	63.93	0.923	43.054	75.000
155.412	66.16	0.939	44.538	75.000
155.451	66.73	0.943	44.901	75.000
155.490	66.40	0.941	44.648	75.000
155.530	66.16	0.939	44.459	75.000
155.569	66.03	0.938	44.343	75.000
155.608	65.87	0.937	44.208	75.000
155.647	65.72	0.936	44.083	75.000
155.686	66.11	0.939	44.318	75.000
155.726	65.33	0.933	43.770	75.000
155.765	65.51	0.935	43.862	75.000
155.804	63.47	0.920	42.461	75.000
155.843	63.43	0.920	42.409	75.000
155.882	63.01	0.917	42.106	75.000
155.922	61.55	0.906	41.09[illegible]	75.000
155.961	61.87	0.908	41.2[illegible]	75.000
156.000	63.51	0.920	42.3[illegible]	75.000
156.039	59.89	0.894	39.913	75.000
156.078	59.03	0.887	39.309	75.000
156.118	59.25	0.889	39.438	75.000
156.157	58.23	0.881	38.727	75.000
156.196	57.33	0.874	38.107	75.000
156.235	58.41	0.883	38.807	75.000
156.274	55.80	0.863	37.038	75.000
156.314	56.13	0.865	37.239	75.000
156.353	56.23	0.866	37.280	75.000
156.392	53.68	0.846	35.560	75.000
156.431	55.80	0.863	36.952	75.000
156.470	53.93	0.848	35.688	75.000
156.510	52.59	0.837	34.771	75.000
156.549	51.89	0.832	34.290	75.000
156.588	50.91	0.824	33.615	75.000
156.627	50.99	0.825	33.648	75.000 Peak = 155.70055

STD(Peak) = 0.00772

Applied Stress = 54.0282 MPa
Psi = 0.000
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
154.746	43.44	0.761	22.864	75.000
154.785	43.19	0.759	22.727	75.000

154.902	43.99	0.766	23.141	75.000
154.942	45.41	0.778	23.892	75.000
154.981	44.08	0.767	23.184	75.000
155.020	45.87	0.782	24.125	75.000
155.059	46.11	0.784	24.249	75.000
155.098	45.55	0.779	23.950	75.000
155.138	47.35	0.795	24.898	75.000
155.177	48.27	0.802	25.381	75.000
155.216	48.63	0.805	25.568	75.000
155.255	51.71	0.830	27.193	75.000
155.294	50.83	0.823	26.724	75.000
155.334	52.23	0.834	27.461	75.000
155.373	53.67	0.846	28.219	75.000
155.412	53.63	0.846	28.194	75.000
155.451	55.19	0.858	29.015	75.000
155.490	55.84	0.863	29.357	75.000
155.530	56.20	0.866	29.543	75.000
155.569	56.91	0.871	29.913	75.000
155.608	55.92	0.863	29.387	75.000
155.647	57.08	0.872	29.997	75.000
155.686	57.36	0.875	30.141	75.000
155.726	58.81	0.886	30.906	75.000
155.765	56.23	0.866	29.534	75.000
155.804	55.17	0.858	28.973	75.000
155.843	58.39	0.882	30.668	75.000
155.882	57.16	0.873	30.015	75.000
155.922	56.47	0.868	29.645	75.000
155.961	55.52	0.860	29.141	75.000
156.000	55.96	0.864	29.369	75.000
156.039	56.48	0.868	29.640	75.000
156.078	54.23	0.850	28.447	75.000
156.118	52.11	0.834	27.324	75.000
156.157	54.31	0.851	28.481	75.000
156.196	51.91	0.832	27.212	75.000
156.235	53.05	0.841	27.813	75.000
156.274	52.68	0.838	27.612	75.000
156.314	51.19	0.826	26.822	75.000
156.353	48.76	0.806	25.540	75.000
156.392	50.68	0.822	26.548	75.000
156.431	49.99	0.816	26.179	75.000
156.470	49.37	0.811	25.853	75.000
156.510	48.56	0.805	25.421	75.000
156.549	47.60	0.797	24.913	75.000
156.588	49.08	0.809	25.688	75.000
156.627	46.56	0.788	24.359	75.000
156.666	46.81	0.790	24.489	75.000
156.706	45.83	0.782	23.967	75.000
156.745	46.00	0.783	24.055	75.000
156.784	45.85	0.782	23.975	75.000
156.823	45.41	0.778	23.741	75.000
156.862	46.37	0.786	24.242	75.000
156.902	45.00	0.775	23.518	75.000
156.941	45.16	0.776	23.599	75.000
156.980	44.43	0.770	23.211	75.000
157.019	43.83	0.764	22.893	75.000
157.098	43.59	0.762	22.761	75.000
157.137	43.24	0.759	22.576	75.000 Peak = 155.88142

STD(Peak) = 0.00783

Applied Stress = 53.7993 MPa
Psi = 18.430
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
154.942	44.96	0.707	25.568	90.000
154.981	46.21	0.717	26.279	90.000
155.020	47.36	0.725	26.927	90.000
155.059	47.49	0.726	26.996	90.000
155.098	47.83	0.729	27.186	90.000
155.138	49.79	0.744	28.298	90.000
155.177	51.13	0.754	29.059	90.000

155.216	51.74	0.758	29.401	90.000
155.255	52.99	0.767	30.105	90.000
155.294	56.02	0.789	31.834	90.000
155.334	54.78	0.780	31.113	90.000
155.373	55.09	0.782	31.283	90.000
155.412	57.42	0.799	32.610	90.000
155.451	58.74	0.808	33.358	90.000
155.490	57.98	0.803	32.910	90.000
155.530	60.57	0.820	34.383	90.000
155.569	58.84	0.809	33.389	90.000
155.608	58.21	0.804	33.018	90.000
155.647	59.38	0.812	33.676	90.000
155.686	59.80	0.815	33.909	90.000
155.726	60.68	0.821	34.401	90.000
155.765	60.33	0.819	34.196	90.000
155.804	58.77	0.808	33.292	90.000
155.843	59.93	0.816	33.949	90.000
155.882	59.21	0.811	33.528	90.000
155.922	58.46	0.806	33.088	90.000
155.961	58.33	0.805	33.010	90.000
156.000	56.64	0.793	32.039	90.000
156.039	58.64	0.807	33.170	90.000
156.078	58.28	0.805	32.953	90.000
156.118	57.78	0.801	32.659	90.000
156.157	55.50	0.785	31.354	90.000
156.196	55.99	0.789	31.624	90.000
156.235	54.20	0.776	30.598	90.000
156.274	53.87	0.774	30.401	90.000
156.314	53.62	0.772	30.254	90.000
156.353	52.83	0.766	29.798	90.000
156.392	52.28	0.762	29.475	90.000
156.431	51.29	0.755	28.906	90.000
156.470	51.83	0.759	29.207	90.000
156.510	50.81	0.751	28.620	90.000
156.549	50.42	0.748	28.392	90.000
156.588	48.90	0.737	27.522	90.000
156.627	50.09	0.746	28.189	90.000
156.666	48.71	0.736	27.401	90.000
156.706	47.71	0.728	26.828	90.000
156.745	46.82	0.721	26.318	90.000
156.784	46.40	0.718	26.073	90.000
156.823	45.90	0.714	25.784	90.000
156.862	47.12	0.724	26.468	90.000
156.902	46.68	0.720	26.210	90.000
156.941	44.98	0.707	25.243	90.000
156.980	45.76	0.713	25.676	90.000
157.019	45.30	0.709	25.412	90.000 Peak = 155.86404

STD(Peak) = 0.00683

Applied Stress = 53.7993 MPa
Psi = 26.570
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
154.981	46.40	0.718	27.486	90.000
155.020	47.12	0.724	27.907	90.000
155.059	48.60	0.735	28.778	90.000
155.098	47.82	0.729	28.305	90.000
155.138	51.28	0.755	30.355	90.000
155.177	53.02	0.768	31.384	90.000
155.216	52.62	0.765	31.135	90.000
155.255	54.54	0.778	32.270	90.000
155.294	55.96	0.788	33.100	90.000
155.334	55.84	0.788	33.023	90.000
155.373	57.50	0.799	33.998	90.000
155.412	60.49	0.820	35.768	90.000
155.451	59.28	0.812	35.034	90.000
155.490	60.70	0.821	35.870	90.000
155.530	60.48	0.820	35.725	90.000
155.569	60.03	0.817	35.449	90.000
155.608	61.90	0.829	36.548	90.000

155.647	61.71	0.828	36.424	90.000	
155.686	61.66	0.828	36.378	90.000	
155.726	61.29	0.825	36.148	90.000	
155.765	60.97	0.823	35.945	90.000	
155.804	62.11	0.831	36.613	90.000	
155.843	60.37	0.819	35.564	90.000	
155.882	61.77	0.828	36.384	90.000	
155.922	61.38	0.826	36.141	90.000	
155.961	58.76	0.808	34.573	90.000	
156.000	58.99	0.810	34.700	90.000	
156.039	57.47	0.799	33.786	90.000	
156.078	57.31	0.798	33.683	90.000	
156.118	56.13	0.790	32.974	90.000	
156.157	56.29	0.791	33.056	90.000	
156.196	56.70	0.794	33.288	90.000	
156.235	55.00	0.782	32.272	90.000	
156.274	52.63	0.765	30.863	90.000	
156.314	54.40	0.777	31.896	90.000	
156.353	52.82	0.766	30.954	90.000	
156.392	52.01	0.760	30.465	90.000	
156.431	51.66	0.758	30.246	90.000	
156.470	52.10	0.761	30.498	90.000	
156.510	51.80	0.759	30.311	90.000	
156.549	51.91	0.759	30.366	90.000	
156.588	50.20	0.747	29.349	90.000	
156.627	50.07	0.746	29.261	90.000	
156.666	49.97	0.745	29.192	90.000	
156.706	49.03	0.738	28.634	90.000	
156.745	48.94	0.737	28.572	90.000	
156.784	47.99	0.730	28.002	90.000	
156.823	46.73	0.721	27.256	90.000	
156.862	47.37	0.725	27.618	90.000	
156.902	47.08	0.723	27.440	90.000	Peak = 155.83499

STD(Peak) = 0.00678

Applied Stress = 53.7993 MPa
Psi = 33.210
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.020	49.36	0.686	30.447	105.000
155.059	50.77	0.695	31.311	105.000
155.098	50.13	0.691	30.902	105.000
155.138	51.39	0.700	31.670	105.000
155.177	53.88	0.716	33.201	105.000
155.216	55.37	0.726	34.117	105.000
155.255	57.21	0.738	35.245	105.000
155.294	58.68	0.748	36.142	105.000
155.334	58.62	0.747	36.092	105.000
155.373	59.10	0.750	36.373	105.000
155.412	62.44	0.771	38.435	105.000
155.451	63.68	0.779	39.189	105.000
155.490	62.80	0.773	38.629	105.000
155.530	61.55	0.766	37.839	105.000
155.569	60.94	0.762	37.445	105.000
155.608	62.10	0.769	38.150	105.000
155.647	62.54	0.772	38.407	105.000
155.686	62.21	0.770	38.184	105.000
155.726	63.50	0.778	38.966	105.000
155.765	62.31	0.770	38.218	105.000
155.804	61.74	0.767	37.849	105.000
155.843	61.86	0.768	37.904	105.000
155.882	59.87	0.755	36.658	105.000
155.922	61.10	0.763	37.403	105.000
155.961	60.51	0.759	37.029	105.000
156.000	59.93	0.756	36.655	105.000
156.039	58.75	0.748	35.912	105.000
156.078	58.63	0.747	35.821	105.000
156.118	58.66	0.747	35.824	105.000
156.157	57.12	0.738	34.865	105.000
156.196	56.64	0.734	34.552	105.000

156.235	56.78	0.735	34.626	105.000
156.274	54.28	0.719	33.072	105.000
156.314	55.27	0.725	33.667	105.000
156.353	53.87	0.716	32.794	105.000
156.392	53.56	0.714	32.594	105.000
156.431	55.23	0.725	33.603	105.000
156.470	51.72	0.702	31.441	105.000
156.510	51.29	0.699	31.160	105.000
156.549	50.95	0.697	30.943	105.000
156.588	50.48	0.693	30.640	105.000
156.627	50.02	0.690	30.348	105.000
156.666	48.35	0.679	29.317	105.000
156.706	49.60	0.687	30.068	105.000
156.784	47.90	0.675	29.009	105.000
156.823	47.95	0.676	29.027	105.000 Peak = 155.77760

STD(Peak) = 0.00689

Applied Stress = 53.7993 MPa
Psi = 39.230
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.020	50.15	0.818	32.216	75.000
155.059	50.49	0.821	32.424	75.000
155.138	54.39	0.852	34.905	75.000
155.177	54.69	0.854	35.085	75.000
155.216	56.59	0.869	36.290	75.000
155.255	59.01	0.887	37.838	75.000
155.294	58.80	0.885	37.682	75.000
155.334	60.25	0.896	38.600	75.000
155.373	60.65	0.899	38.839	75.000
155.412	62.53	0.913	40.032	75.000
155.451	64.96	0.931	41.577	75.000
155.490	66.43	0.941	42.502	75.000
155.530	63.17	0.918	40.385	75.000
155.569	63.32	0.919	40.460	75.000
155.608	63.52	0.920	40.569	75.000
155.647	64.88	0.930	41.424	75.000
155.686	64.45	0.927	41.129	75.000
155.726	64.33	0.926	41.032	75.000
155.765	63.51	0.920	40.481	75.000
155.804	63.03	0.917	40.154	75.000
155.843	63.12	0.917	40.194	75.000
155.882	61.80	0.908	39.328	75.000
155.922	62.13	0.910	39.523	75.000
155.961	61.09	0.903	38.838	75.000
156.000	60.32	0.897	38.324	75.000
156.039	60.37	0.897	38.340	75.000
156.078	57.41	0.875	36.430	75.000
156.118	58.93	0.886	37.383	75.000
156.157	56.64	0.869	35.902	75.000
156.196	57.24	0.874	36.267	75.000
156.235	55.67	0.862	35.247	75.000
156.274	56.47	0.868	35.739	75.000
156.314	54.44	0.852	34.432	75.000
156.353	56.44	0.867	35.688	75.000
156.392	54.71	0.854	34.568	75.000
156.431	53.80	0.847	33.976	75.000
156.470	53.71	0.846	33.900	75.000
156.510	53.32	0.843	33.638	75.000
156.549	51.65	0.830	32.565	75.000
156.588	51.13	0.826	32.220	75.000
156.627	51.99	0.833	32.745	75.000 Peak = 155.74198

STD(Peak) = 0.00782

Applied Stress = 53.7993 MPa
Psi = 45.000
Background Intensity = 0.00

Two-Theta	Intensity	STD(Intensity)	Corrected Int	Time
155.059	53.51	0.714	36.255	105.000

155.098	52.61	0.708	35.615	105.000
155.138	56.08	0.731	37.960	105.000
155.177	57.45	0.740	38.874	105.000
155.216	58.80	0.748	39.774	105.000
155.255	60.99	0.762	41.246	105.000
155.294	63.27	0.776	42.775	105.000
155.334	63.39	0.777	42.834	105.000
155.373	63.01	0.775	42.549	105.000
155.412	65.55	0.790	44.258	105.000
155.451	67.74	0.803	45.726	105.000
155.490	67.22	0.800	45.341	105.000
155.530	66.80	0.798	45.029	105.000
155.569	65.86	0.792	44.361	105.000
155.608	65.10	0.787	43.816	105.000
155.647	66.04	0.793	44.431	105.000
155.686	66.35	0.795	44.619	105.000
155.726	65.10	0.787	43.739	105.000
155.765	65.11	0.787	43.726	105.000
155.804	64.08	0.781	42.996	105.000
155.843	64.68	0.785	43.378	105.000
155.922	62.34	0.771	41.748	105.000
155.961	62.23	0.770	41.646	105.000
156.000	61.12	0.763	40.876	105.000
156.039	61.83	0.767	41.328	105.000
156.078	58.72	0.748	39.210	105.000
156.118	58.65	0.747	39.136	105.000
156.157	58.96	0.749	39.325	105.000
156.196	59.02	0.750	39.340	105.000
156.235	58.34	0.745	38.862	105.000
156.274	56.93	0.736	37.893	105.000
156.314	56.10	0.731	37.308	105.000
156.353	55.33	0.726	36.776	105.000
156.392	54.70	0.722	36.327	105.000
156.431	55.80	0.729	37.046	105.000
156.470	53.59	0.714	35.546	105.000
156.510	53.60	0.714	35.531	105.000
156.549	53.35	0.713	35.345	105.000
156.588	52.70	0.708	34.892	105.000
156.627	51.76	0.702	34.243	105.000 Peak = 155.70263

STD(Peak) = 0.00745

S1 = -1.12E-06 +/- 1.50E-07
Counting Error = 1.31E-07
Instrumental Error = 7.26E-08

S2/2 = 4.48E-06 +/- 4.38E-07
Counting Error = 4.34E-07
Instrumental Error = 5.40E-08

Applied Stress	Slope	Intercept
2.03E+02	1.60E-03	1.17E+00
1.48E+02	1.30E-03	1.17E+00
1.03E+02	9.99E-04	1.17E+00
5.38E+01	8.33E-04	1.17E+00

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9 REFERENCES

[1] I.C. Noyan and J.B. Cohen, Residual Stress: Measurement by Diffraction and Interpretation, Springer-Verlag, New York, (1987).

[2] L.H. Schwartz and J.B. Cohen, Diffraction from Materials, Springer-Verlag, New York, (1987).

[3] R.A. Winholtz and J.B. Cohen, Generalized Least-squares Determination of Triaxial Stress States by X-ray Diffraction and the Associated Errors, Aust. J. Phys., 41, 189-199, (1988).

[4] M.R. James and J.B. Cohen, Study of the Precision of X-ray Stress Analysis, Adv. X-ray Anal., 20, 291-307, (1977).

[3] R.A. Winholtz and J.B. Cohen, Separation of the Macro- and Micro-Stresses in Plastically Deformed 1080 Steel, Adv. X-ray Anal., 32, 341-353, (1989).

[6] K. Perry, I.C. Noyan, P.J. Rudnik, and J.B. Cohen, The Measurement of Elastic Constants and the Determination of Stresses by X-rays, Adv. X-ray Anal., 27, 159-170, (1984).

[7] R.H. Marion, Ph.D. Thesis, Northwestern University, (1972).

[8] J.A. Ibers and W.C. Hamilton eds., International Tables for X-ray Crystallography, Vol II, The Kynoch Press, Birmingham, England (1972).

[9] M.R. James, Ph.D. Thesis, Northwestern University, (1977).

[10] T.J.Devine and J.B. Cohen, Profile Fitting in Residual Stress Determination, Adv. X-ray Anal., 29, 89-101, (1986).

Appendix A

List of Interface Product Suppliers

MSTEP-5 Card
CTM-5 Card
MetraByte Corporation
440 Myles Standish Boulevard
Tauton, MA 02780
(617) 880-3000

PC-14 I/O Card
El Toro Systems
22865 Lake Forest Drive
El Toro, CA 92630
(714) 770-1474

IBM Data Aquistion and Control Adapter Card
IBM Coporation
44 South Broadway
White Plains, NY 10601

Turbo Pascal
Turbo Debugger
Borland International
1800 Green Hills Road
P.O. Box 660001
Scotts Valley, CA 95066-0001

Technojock Turbo Toolkit
Bob Ainsbury
P.O. Box 2197
Houston, TX 77252
Also available on many computer bulletin boards.

Stepper Motor Drivers
Electronic Products
P.O. Box 891
Mt. View, CA 94042
(415) 969-5829

Multi-Channel Analyzer
LeCroy Research Systems Corporation
700 South Main Street
Spring Valley, NY 10977
(914) 425-2000

PSD System
TEC
P.O. Box 22996
10770 Dutchtown Road
Knoxville, TN 37922

Load Cell and Strain Gauge Products
Sensotec
1200 Chesapeake Ave.
Columbus, OH 43212

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2b. GROUP

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13. ABSTRACT

Software is described for the measurement of residual stresses and x-ray elastic constants on a diffractometer under computer control. The computer and interfaces to the hardware are relatively inexpensive and may be set up with only moderate electronic and programming expertise. Both biaxial and triaxial stress measurements may be made to an operator specified error. Measurements of the x-ray elastic constants may also be made to a pre-specified error. Additionally, programs for use data collection are described which allow the data to be processed separately at a later time.

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Stress measurements Eleastic constants Biaxial Triaxial Diffractometer						